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## THE TELEPHONE IN LONDON.

GENIAL Mr. Brand, in his own pleasant, hearty way, laughingly pushed aside all hostile criticism at the United Telephone Company's meeting last Tuesday. "We have done the best we could," was his unvarying answer, "but we are beset by unexampled difficulties." And we are sorry to say that it is only too true that many unnecessary obstacles are placed in the way of telephonic progress. The complication and unweildiness of London in themselves make it no easy task to run the wires of an exchange, or of a system of exchanges, in a satisfactory manner; but when to these natural difficulties are added the obstinacy and churlishness of private individuals, and the opposition, though mainly passive, of the Post Office, the situation becomes exasperating. We are all apt to complain pretty freely of the lapses and shortcomings of the telephone company, but we seldom bethink ourselves, probably, of the disadvantages under which it labours. We see badly-erected spans of wires and do not wonder that they fall when the snow comes, and blame the company for putting up its wires in such a fashion; we want to be connected with the exchange and are astonished and indignant when we find that months perhaps pass before we are able to enjoy the benefits of telephony; and when at length we are "on the exchange" delays of a minute or so when we wish to speak to a friend or a customer irritate us exceedingly. But we never trouble our heads as to the causes which produce such unpleasant effects. To all these complaints Mr. Brand replies, "We have done the best we could." Then he proceeds to enumerate the difficulties of the position. "We have no compulsory powers," he says, "and cannot put our wires at all times where we would, so we have to put them where we can. Householders will persist in refusing permission for standards to be placed upon their roofs or for wires to be fastened in any way to their houses; and even where we do extract their consent the roofs are often too weak to bear any reasonable strain. Wayleaves are in some cases not to be obtained for love or money, and would-be subscribers and *their* money are sent sadly, sometimes angrily, away. Then the number of subscribers and their calls outgrew our facilities; but we have provided new switchboards, the best in the world, and that trouble will be removed." Such are his answers; and whether we feel satisfied with them or not, we accept them and hold our tongues. Mr. Brand is polite and pleasant, and his soft answer has little difficulty in turning away wrath for the time; but, unfortunately, all the officials of the United Telephone Company have not profited by association with its urbane and good-humoured chairman, and their method of replying to complaints and enquiries is often calculated to increase rather than allay irritation. These do not so readily impress us with the belief that all that can reasonably be expected is done to meet the requirements of the subscribers and to avoid the practical difficulties in working the system. Mr. Abbott expressed the view held, we venture to say, by the majority of the subscribers to the London exchange when he said that there was a want of vigour in the administration. One important direction in which a vigorous policy would seem to be demanded is in regard to the extension of trunk lines from London to large towns and cities in the Midlands and the North. Mr. Brand spoke almost despondingly upon this question, and seemed to think telephony between towns far apart was not practicable under existing circumstances or under any circumstances likely to arise. With the knowledge that a line is working between the capitals of France and Belgium, a distance of over 200 miles, in a perfectly satisfactory manner, few people will be inclined to accept Mr. Brand's view of the matter. It is scarcely conceivable that the conditions across the English Channel are so entirely different that what is there found easy of accomplishment is here positively impracticable. We are told, however, that experiments are still being made, and with this scant consolation we must perforce be content, retaining our former conviction that if the company is in earnest and really desires to establish inter-city lines it will eventually and ere long succeed. In the meantime it would be interesting to learn what degree of success has attended the opening of the London-Brighton line. If this has proved impracticable it is certainly not the fault of construction so far as the conductor is concerned. Is it too much to hope for that the authorities at St. Martin's-le-Grand will cease to frown upon and hamper the telephone, will in fact redeem their promise not to refuse existing facilities to the United Company, which, whatever its faults, should at least have fair play?

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OTHER daily papers are following the bad example set them by the *Times* in regard to scientific matters. We cut the following from the *Morning Post* of the 1st inst.:—"A new electric boat, built by Messrs. Lester and Perkins, Royal Albert Docks, to the order of the Electric Locomotive Company, is now fitting out in the Victoria Dock, and will, on completion, go down to Spithead for the Royal Jubilee Naval Review. The craft is an entirely new departure in electric motion, as, in addition to the 400 cells with which her main engines will be worked, she will be fitted with a donkey engine to be used as an auxiliary, *its motive power being derived from the force accumulated by the vessel's passage through the water*." The paragraph refers to the Elieson launch, of which we have already spoken, the italics being ours, but the question which now interests us is—Who got hold of that reporter? It is unlikely that he evolved the above nonsense out of his inner consciousness, for reporters generally rely on the knowledge of their informants if they are themselves unacquainted with the subject. We can only

hope that the officials of the E. L. C. are not responsible for the paragraph, and would advise the *Morning Post* to stick to its proper work of chronicling the little doings of big people, leaving electricity and kindred subjects alone; or, if it deems electrical matters of sufficient general interest to warrant its devoting attention to them, at least to bear in mind the well-worn adage that what is worth doing at all is worth doing well. No good end of any kind is served by the spread of misinformation.

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WE have a dim recollection of having seen the trembling bell arrangement described by M. Letang on page 30 applied to a similar purpose some years ago. Perhaps some of our readers may be able to refresh our memory.

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IF the facts are as stated in a paragraph on another page, the Post Office would not seem to have acted in a very becoming manner in the dispute regarding the public telegraph offices on the Lancashire and Yorkshire Railway. The company thought it was entitled to a larger amount of commission than the Post Office felt disposed to allow, and, pending a definite agreement, asked for time. But the bureaucratic department declined to parley, ordering the offices to be closed at once. The public suffers a good deal of inconvenience, but this probably troubles the Postal Telegraph officials not at all. They have shown their independence and are happy. Perhaps if the directors of the railway company approached them in humble attitude and implored them to restore the *status quo ante bellum* they would be graciously pleased once more to permit the public to do part of its telegraphing from the railway stations. More facilities, and not fewer, are wanted in this direction, and this fact should be impressed upon the gentlemen at the Post Office, who, in their zeal for economy, seem inclined to forget their first duty.

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THE "local authority" is the *bête noir* of the electrician; or shall we reverse the formula, and say that the electrician is the *bête noir* of the local authority? Whichever way it is, the two are continually at loggerheads, whether upon the question of overhead wires, upon that of electric lighting, or, as now, in regard to electrical tramways. The Metropolitan Board of Works contended before a Select Committee of the House of Commons last week and this that in it, as local authority, was vested the power of granting permission to the West Metropolitan Tramways Company to use electrical or other mechanical power (excepting steam) for the propulsion of its cars. A very decided snub, however, was administered to this ambitious body, for its contention was overruled, and the Tramway Company's Bill passed through committee. This last fact is highly satisfactory. It is no light thing to secure an Act of Parliament, and the West Metropolitan deserves success for so quickly following in the footsteps of its fellow in the north.

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THE inaugural meeting of the National Association for the Promotion of Technical Education was held at the rooms of the Society of Arts on Friday last, and was highly successful, inasmuch as a large number of eminent men and men of position showed their sympathy with the objects of the association by attending and joining the council which was formed. Lord Hartington presided, Sir Lyon Playfair and Sir John Lubbock, as might have been expected, were prominent, and Lord Rosebery and Mr. John Morley, as well as about forty other members of Parliament, were also present. With such distinguished support the association should meet with more than ordinary success.

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"DISCRETION is the better part of valour"—sometimes. It has reached us that there is a tendency on the part of some large users of transformers to recognise the patents of Messrs. Gaulard & Gibbs as comprehensive in regard to these apparatus. This may, in some cases, be a more wise proceeding than to risk a chance of becoming defendants in a law suit, so proverbially a matter of uncertainty. Mr. Rankin Kennedy's writings on transformers—which are about to be published in a collected form—will probably enlighten many people who have not investigated this subject very closely.

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WE are inclined to agree with the *Statist* that a commission of enquiry into the bye-ways of company promotion is necessary. The City, that excellent paper says, is overrun with professional prospectus jugglers, each of whom has his own special methods, and plays, as it were, his own game. What fearful evidence of the existence of this disreputable class has come under our own observation! As most of our readers know, electricity and the electric light were fastened upon, tooth and nail, by these unscrupulous, gold-hungering sharks a very few years ago; and electric industries have not entirely recovered even yet from the evil reputation brought upon them by the association.

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THE return which Mr. Raikes, the Postmaster-General, has promised respecting the proportion of stock and betting messages to the bulk of telegrams sent at the sixpenny rate, will be awaited with some interest. It will be a sorry reflection upon the arguments of those who advocated the sixpenny tariff if it turns out that it is the betting man and the stock speculator who mainly profit by the reduced charge. We had hoped that a lower rate would promote freer intercourse by means of the telegraph upon business and even social matters. We still hope that Mr. De Lisle's supposition, so far at least as the two classes named are concerned, is not a correct one.

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GAS engineers are beginning to see that after all the electric light is not their natural enemy. Mr. Foulis, this year's president of the Gas Institute, repeated in his presidential address what has been said more than once before during the last two or three years, by ourselves amongst others. That is, that to the electric light the gas companies are indebted for a largely increased consumption of their own commodity. People who have been brought much into contact with the electric light away from home have been gradually accustomed to brighter light than at one time satisfied them, and they have looked for and obtained a corresponding increase of illumination in their own houses. That is one way in which the newcomer has proved the friend instead of the rival of the older illuminant, and it is not the only one.

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WE admire Mr. Hugh Watt's pluck if it is really a fact that he will move the resolution anent the Electric Lighting Act published, in connection with his name, in the *Daily News* last week. We were, as our readers well know, strongly opposed to the retention of the principle of the notorious 27th clause, the principle, that is to say, of compulsory purchase without compensation and at an old iron valuation; but the promoters

of Lord Thurlow's last Bill thought it the wiser course to accept half a loaf rather than have no bread at all, and accordingly acquiesced in the mere modification of the terms of the clause. Mr. Watt boldly calls for the repeal of the entire Act, and says that no measure short of that and the substitution of legislation rendering it possible to supply electric light to the public with a fair prospect of remunerative returns will be of any benefit to the electric lighting industry. We should be glad to see the Act of 1882 repealed; but we doubt very much if even the most favourable legislation would, of itself, "render it possible to supply electric light to the public with a fair prospect of remunerative returns." Something else is required to render this possible, and that something must be found by the companies independently of Parliament. Still, push on, Mr. Watt!

## SOME NOTES ON ELECTRIC LIGHTING IN THE UNITED STATES.

[A COMMUNICATION FROM ABROAD.]

IF anything were wanting to prove the great popularity of the electric light in the United States, the marvellous rapidity with which it is gaining ground in the prairie cities would alone supply that want. Eighteen months ago there was not an electric light to be seen between Omaha and North Platte, Neb. Now, however, the Brush Company has a lighting station at Columbus, Neb., and is rapidly gaining ground in all directions in Nebraska. Keen competition in the east seems to have had the effect of driving some of the newer companies out west, to open out new fields for their electric lighting apparatus. But, even in a place like Omaha, for example, it is quite evident that business is not to be done without some fighting, and some places in that city which formerly were lighted by Sperry lamps, are now lighted on the Thomson-Houston system. Indeed, as far as arc lighting is concerned, the day has gone by when any particular company may be said to enjoy a monopoly. Not so, however, with incandescent lighting. Already the Edison Company has now over half-a-million lamps in use, and over one hundred central stations at work in the United States, and when all threatened litigation is at an end, this company will, no doubt, secure as complete a monopoly in regard to the modern incandescent lamp as they now have in Great Britain. To resume, however: to the general electric lighting, especially in cities, Chicago is yet behind other important cities, in that the streets are still lighted by gas. The Chicago people have not yet permitted the overhead electric light wires, and it is not likely, with the high tension systems now in use, that the wires will be put underground.

The Fort Wayne Jenney Company has made a start in Chicago. There is another company called *the* Jenney Company, and they do a good business also. From all accounts the two Jenney companies are not on very friendly terms with each other. Mr. Jenney, sen., is electrician to the Fort Wayne Company, and Mr. Jenney, jun., his son, is electrician to *the* Jenney Company. Which system is the better it would be difficult to say, for they both claim to have invented the best on earth. There is just about as much difference between them as there is between a spade and a shovel. Their arc lamps are of the short arc type like the Weston. By-the-bye, the United States Company has introduced a new design of Weston arc lamp. The lamp and globe together have a neat appearance, with the exception of two pieces of wood at the top of the lamp, like those used in the old types of Brush hanging lamp, for making connection by the weight of the lamp. Quite a number of these new Weston lamps are used in the Palmer House at Chicago, and one can even find them in the corridors on the different floors instead of incandescent lamps or gas. They are not very steady, in fact, flicker a good deal, besides making the continual hissing noises frequent in lamps working with a short arc.

Another company having a neat looking lamp is the Excelsior or Hochhausen Company, whose business is ever increasing. We have sometimes heard that "a prophet hath honour except in his own country;" but this adage evidently does not hold true in regard to the Excelsior Company, who have something like 2,000 arc lamps in operation in the city of Brooklyn, where their apparatus is made. The Thomson-Houston Company, however, do the street lighting in Brooklyn, but their lamps are placed too high for the light they give. Altogether we may take it that there are nearly a quarter of a million arc lights and 600,000 to 700,000 incandescent lights in operation in the United States.

With all this marvellous development it is pitiable to notice that there is no improvement in the fixing of the arc lamps—not even an attempt at improvement. The same unsightly poles, the same wires dangling everywhere, still exist, and as business grows, they multiply.

Turning to New York, we find there is a constantly increasing demand for both arc and incandescent lights, and the number of lamps now in use in that city has become so great that the electric light must already have produced an unpleasant effect upon the receipts of the gas companies. For it must not be forgotten that as the demand for electric lighting increases, the price at which further lights can be supplied is sensibly lessened; while, on the other hand, as the gas consumption diminishes, the cost must be increased for those lights remaining in order to pay the same dividend upon the capital invested. If, therefore, the demand for electric lighting increases in New York and other cities in the same ratio as it has done during the past two years, then the outlook for the gas companies is indeed most gloomy. English electricians are too prone to think that the Electric Lighting Act is solely responsible for the lack of interest which has been shown by the British public in regard to electric lighting, which is everywhere awakened in the United States. But this is not so. The opinion formed some time ago by the writer that the true stumbling block to the rapid development of the electric light in England—an opinion strengthened by several visits to the States—is the fact that in our own country gas is cheap and of excellent quality.

## THE PARIS-BRUSSELS TELEPHONIC LINE.

RESPECTING the working of the telephonic line between Paris to Brussels, opened for public use on February 24th, M. de la Touanne gave a most interesting communication to the International Society of Electricians on May 4th, adding some figures and diagrams relating to this important installation.

*Overhead line.*—Total length of wire (double line) 628 kilometres. Silicious bronze wires in France. Phosphor bronze wires in Belgium. Diameter 3 millimetres. Breaking strain, 42 to 45 kilogrammes per square mm. Conductivity, 96 to 98 per cent. of pure copper.

*Underground cable.*—Fortin-Hermann cable, a cable of copper wires on which are strung beads of paraffined wood. Capacity, about five times less than that of ordinary cables without gutta-percha, or 0·045 to 0·04 of a microfarad per kilometre. The insulation resistance has reached as much as 10,000 megohms per kilometre.

*Microphones and telephones.*—At Paris, D'Arsonval transmitters with D'Arsonval or Aubry receivers, Lalande and Chaperon batteries. At Brussels, Berliner

or Dejongh microphones, Bell receivers, and Warnon batteries.

Communications between the stations established at the Bourses of Paris and Brussels offer no difficulty as regards installation. Without excepting the employment of simultaneous telegraphic and telephonic communications, they come into the ordinary case of two stations, A and B, connected by a double wire, which is most simple.

With regard to communications between town subscribers, special arrangements have been made to ensure a good service.

*Communications between town subscribers.* — Until further orders the office of the *Avenue de l'Opéra*, Paris, will establish communications between the subscribers and the Paris-Brussels line. For this purpose a special telephonic cable connects the office of the *Avenue de l'Opéra* with the Bourse office. The connections with the subscribers at Paris that possess the double wire will be direct without any derivation. But the correspondent must be able to indicate the end of the conversation.

As the line is cut by two condensers, we must not think of giving a signal on the telephonic line by a continuous current any more than we must change the order of things by modifying the station of each subscriber.

The notice of the end of the conversation is given at the Bourse station by an electro-magnet, A, presenting a large coefficient of self-induction, playing the part of an annunciator, and placed in derivation on the wires coming from the *Avenue de l'Opéra* in front of the condensers, $C_1$ and $C_2$. This annunciator in no way interferes with telephonic communications characterised by alternating currents of very short periods, for which the electro-magnet, A, constitutes an impassable derivation.

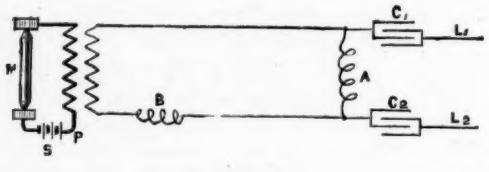


FIG. 1.

S, subscriber; A, Bourse; B, Avenue de l'Opéra office. Arrangement of the telephonic circuits enabling the end of the conversation to be indicated at the Bourse and the Avenue de l'Opéra.

It still remained to notify to the office of the *Avenue de l'Opéra* the end of the conversation. For this purpose the *Société Générale des Telephones* proposed to employ a relay invented by M. Ader, and this suggestion has been adopted. This relay consisted of a slight coil placed in the magnetic field produced by a permanent magnet, and closing, during its action, a local circuit. This bobbin introduced into the circuit, having only 50 ohms resistance and a low coefficient of self-induction, in no way impedes telephonic transmission. The end of the conversation being thus announced simultaneouly at the Bourse office and at the *Avenue de l'Opéra*, there is no need to transmit messages which would occasion loss of time.

*Subscribers connected directly with the Bourse.*—A certain number of subscribers possess lines connecting their residences directly with the Bourse. If the subscriber lives at a distance, it would be necessary in order to call him, to employ a powerful battery to magnetise his annunciator placed at the Bourse, but this would give rise to remanent magnetism which would be injurious when the subscriber, in his turn, wished to commnnicate with the Bourse office. This difficulty has been obviated by communicating with the subscriber directly by means of a magneto-electric machine placed at the Bourse, working the subscriber's electric bell which itself communicates with the Bourse by its normal battery. By using this combination the annunciator of the Bourse never retains any injurious remanent magnetism.

*Simultaneous telegraphy and telephony.* — Besides acting as an entirely metallic telephonic circuit, each wire serves for a distinct and simultaneous telegraphic communication returning by the earth. Fig. 2 shows the connection between the apparatus allowing of these communications according to the Van Rysselberghe system on the circuit, $L_1$. A is the graduating electro-magnet, C a condenser, A′ a graduating bobbin, and T the earth. The arrangements of the circuit, $L_2$, which serves for a second telegraphic communication are exactly similar.

*Telephonic signals between Paris and Brussels.*—The signal between Paris and Brussels cannot be made by means of direct currents. M. Sieur had at the beginning suggested to M. Van Rysselberghe a special mode of signalling known as the *phonic signal*. This consists of the membrane of a telephone, the bobbin of which is connected with the line after the condensers. On this membrane rests a pendulum moving very freely, which, during rest, short-circuits a local battery. On this local battery branches a local bell not traversed by any current. If we send currents into the line the membrane vibrates, breaks the local circuit and sets the bell ringing.

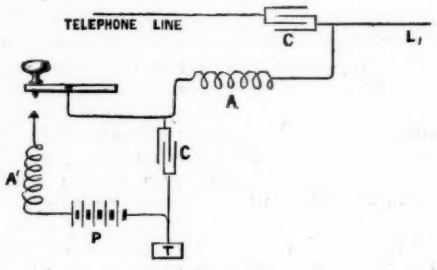


FIG. 2.

Arrangement allowing of simultaneous telegraphic and telephonic communications.

This local battery which is almost always short-circuited, is subjected to considerable wear and tear, which M. de la Touanne has succeeded in reducing by modifying its arrangement.

For this purpose he employs a differential annunciator, one of the circuits of this annunciator is closed directly upon the battery, the other indirectly through the pendulum and the membrane. When at rest the actions annul one another, whereas if the membrane of the phonic signal vibrates, the action of the direct circuit predominates. Under these conditions the battery of the relay, instead of being closed on short-circuit, works upon two resistances in derivation, and the loss is only slight.

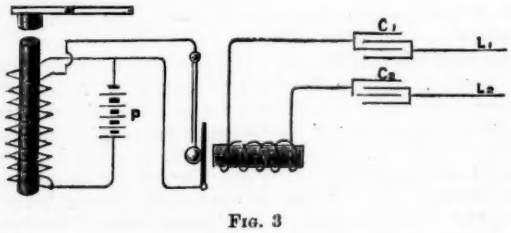


FIG. 3

M. Sieur's phonic signal with M. de la Touanne's differential annunciator.

Such are, briefly, the arrangements adopted at Paris, in order to establish communication between the subscribers and the Paris-Brussels line.

Those employed at Brussels are, if not identically the same, at least equivalent.

On busy days at the Bourse as many as 80 communications have been made in three hours, and from 30

to 32 so-called 5 minutes communication during the busiest hour.

The Paris-Brussels telephonic service thus constitutes an excellent means of communication, and is so fully appreciated that there is a second line to be established, similar to the first, which has become insufficient. What better proof can be given, says "E. H." in *L'Electricien*, of the efficacy and utility of communications between towns?

## ELECTROLYSIS OF ALUMINIUM SALTS.

By ALEXANDER WATT.

(*Continued from page* 5.)

II. *Experiments with Alkaline Solutions (continued).*—51. A new series of experiments was tried with the exhausted aluminate of potash baths, that is, the solutions which had been deprived of their foreign metals in the foregoing experiments, by adding various substances with a view to encourage, if possible, the deposition of aluminium. In the present instance a strong solution of borate of soda was introduced into the bath a little at a time, but this substance failed to induce the metal to part company with its alkaline associate. The bath was worked both cold and warm, with weak and strong currents in succession, but nothing more than a mere trace of metal could be obtained on the cathode—the last fraction of some metallic impurity derived from the alumina.

52. Another exhausted bath was taken, and to this was added in increasing proportion a strong solution of silicate of soda, but this failed to present any advantage at any temperature, either with a weak or strong current.

53. A quantity of aluminate of potash solution was put into a large bottle and bisulphide of carbon added, the whole being repeatedly and well shaken. After about twenty-four hours the solution was tried, but no deposit of aluminium could be obtained. The object of introducing the bisulphide of carbon was to see if carbon in this form would assist the reduction of the metal.

54. Permanganate of potash added to an exhausted aluminate of potash bath did not favour the deposit of aluminium.

55. Phosphate of soda, acetate of soda, acetate of ammonia, and other non-metallic salts, and liquid ammonia were respectively added to aluminate of potash baths after they had ceased to yield deposits of metal, but in no case did they promote the deposition of aluminium.

56. Sugar, glucose, starch, and glycerine were also added to the exhausted baths referred to, but with no advantage.

57. Hypochlorite of soda and hyposulphite of soda were next tried in succession, but without effect.

58. It was found that after the aluminate of potash baths had ceased to deposit metal of any kind upon anodes of platinum, copper, gilding metal, and brass, that a trifling metallic deposit, generally of a yellowish tint, could be obtained upon a cathode of sheet zinc. The film did not appear to thicken after a long immersion, but a second, and even a third plate, would receive a slight coating; this eventually ceased, however, on immersing another prepared plate. An amalgamated zinc plate did not receive a deposit under the same circumstances.

59. In this experiment aluminate of potash was prepared by adding dried hydrate of alumina in excess to caustic potash in a state of fusion; the whole being fused together for a considerable time and the mass then allowed to cool. The aluminate thus formed was afterwards treated with hot water, and the solution obtained used as an electrolyte. No deposit of aluminium, however, could be effected with this bath either in the cold or when heated. Traces of iron, &c., were, as before, obtained upon the plate, but these metallic impurities soon ceased to deposit. It may here be mentioned that the potash used in this and some of the former experiments was the ordinary commercial article, taken from the "drum" in which it was packed, as required, and when used in a liquid form the oxide of iron with which it was impregnated was allowed to subside before employing the liquid. Contrary to expectation, however, it was found that the potash still held in solution considerable traces of iron, which was determined by the ordinary tests. Indeed, when the solution of potash was electrolysed, *per se*, a slight film of iron appeared upon the negative electrode—a strip of copper.

60. Bichromate of potash was added to the above solution of aluminate of potash after it had ceased to yield metallic deposits, but without advantage. Chromate of potash was also tried, with a like result.

61. In this experiment a plate of aluminium was used as an anode in a moderately strong solution of caustic potash, a strip of sheet brass being employed as the cathode. The current was then allowed to pass, when the solution gradually became charged with aluminium. After a time the negative plate became slightly coated with a white metallic film, which eventually assumed a dull grey colour. On examining this first deposit for aluminium no trace of that metal could be detected. A second plate after a short immersion became coated as before with white metal, as also did a third and fourth plate, but the films thus obtained were simply due to impurities from the aluminium, iron being specially conspicuous.

62. A fresh solution of aluminate of soda was tried in this experiment, and after all metallic impurities had been removed by deposition upon a series of plates, and the bath ceased to work, a large excess of cyanide of potassium was added, when a slight film of white metal (not aluminium, however) again appeared upon a newly-prepared plate. After an hour's immersion the plate was removed and another plate substituted, but upon this little or no metal of any kind was perceptible. The solution was next heated, but with no better result.

63. To a portion of the above solution which had not been mixed with cyanide, carbonate of ammonia was added in small quanties at a time; it did not, however, present any advantage.

64. Hydrate of alumina was precipitated from a solution of a very pure sample of sulphate of alumina, by ammonia, and this was afterwards added in considerable excess, to re-dissolve a portion of the precipitate. The solution failed to yield a deposit of aluminium, even with a strong current.

65. A strong solution of potash was next added to the above, a little at a time, and the mixture well stirred, after each addition. When the remaining hydrate became dissolved by the caustic alkali a very slight metallic stain was visible on the negative plate, but no appreciable quantity of metal was obtained. In this case it will be observed that the usual metallic impurities were not present, which was due to the purity of the sulphate of alumina from which the hydrate had been precipitated.

66. A strong solution of cream of tartar was digested with recently precipitated hydrate of alumina, with the application of heat, when a considerable proportion of the hydrate became dissolved. The solution thus obtained was allowed to cool, when it was used as an electrolyte. On immersing a cathode of polished sheet copper, a nearly black metallic film was obtained after a short time, but this, when examined, proved to be chiefly iron. A second plate also received a similar but more intensely black coating; there was no deposition of aluminium from this solution.

67. An attempt was made to deposit aluminium in the form of an alloy; this was suggested by the fact that slight traces of the metal had been observed when examining the various deposits obtained from some of the foregoing baths. In the first instance, a small quantity of a solution of double cyanide of copper and potassium was added to an inactive aluminate of potash bath—a zinc cathode being at first used. In this case a film of copper only was obtained.

In order to be able to dissolve the deposited film without acting upon the metal of the negative electrode, a strip of platinum foil was substituted. The first film obtained upon the platinum did not exhibit the characteristic yellow colour of an aluminium-copper alloy; when dissolved in nitric acid, and tested for aluminium, no trace of that metal could be observed. When all the copper had been worked out of the bath in this way, the liquid re-assumed its former inactivity.

68. Solution of double cyanide of silver and potassium was next added to an aluminate of potash bath, but in this case silver alone was deposited—no trace of aluminium being found when examining the various films deposited upon the cathode.

69. A small jar was partly filled with a solution of aluminate of potash, and in this was immersed a porous cell containing a bar of carbon, surrounded by iron filings; this cell was then filled up with the aluminate solution, and the battery connected as usual—a platinum cathode being employed. No deposit of aluminium, however, was obtained by this arrangement. It became evident, from the foregoing experiments, that metallic aluminium could not be obtained by electrolysing aluminate of potash solutions, under any conditions of temperature or at any degree of concentration, either with weak or strong currents, so this electrolyte was finally abandoned. Before consigning the aluminate of soda baths to a similar fate, further experiments were made, with numerous modifications and additions, but without success. It was believed that in some of the deposits obtained from these solutions there was a slight evidence of aluminium, and it was conjectured that possibly it had formed an alloy with one of the several metals before referred to which deposited from time to time upon the cathodes. The traces of aluminium, however, were so slight, that it would have required a series of very careful experiments to determine which of the metals assisted to form the hypothetical alloy. Several hasty experiments were made in this direction, but were not successful. The object being to obtain metallic aluminium, if possible, by the electrolytic method, the experiments were often made in rapid succession, and every modification that suggested itself was speedily put into execution.

(*To be continued.*)

## A NEW ELECTRIC LIGHT REGULATOR.

By M. LETANG.

THE object aimed at in the construction of this regulator is to obtain an appreciable regulation by means of a simple contrivance not involving any delicate mechanism.

The method used for arriving at this result is based upon the employment of mechanism similar to that of an ordinary vibrating electric bell.

An electro-magnet, attracting an armature, is excited by a derived current between the two carbons of the lamps, and by sufficiently balancing a spring which counterbalances the action of this electro-magnet, the armature is only attracted when the power of the electro-magnet reaches a certain value, which occurs every time the arc exceeds a certain length.

On becoming displaced the armature breaks the circuit traversed by the current exciting the electro-magnet. Being then drawn back by the counteracting spring, it re-establishes the circuit: a second attraction takes place, followed by a second breaking of the current, and so on. By this action a vibratory movement is imparted to the armature, and communicated by it to a hammer fixed to it. The blows of this hammer are utilised for producing very short relaxations of a brake which serves to keep the carbons slightly apart after having separated them in order to form the arc, and which then allows them to approach one another by slow and regular degrees.

Thus this arrangement necessitates no adjustment as regards accuracy, but, nevertheless, it gives highly satisfactory results, such as the following:—

1. The steadiness of the light is very remarkable.
2. We obtain good working with lower intensities than have been employed up to the present.
3. The apparatus works equally well in derivation or in series.
4. By employing very short voltaic arcs, a condition which to a great extent prevents the cooling of the points of carbon, the relation which exists between the luminious intensity and the electrical energy absorbed only decreases slowly in proportion as the intensity of the current passing through the arc diminishes.

With the apparatus working in derivation, for instance, we get a light equal to about 12 carcels, with an intensity of 3 ampères and an electromotive force of 50 volts. The electrical work absorbed is thus, in this case, 12·5 watts or 1·27 kilogrammetres per carcel, or 1·56 watts per candle.

The luminious rendering is increased when the apparatus works in series, principally on account of the suppression of the passive resistances which must necessarily be introduced into the circuit of apparatus working in derivation.

With a current, the constants of which are 3 ampères and 32 volts, we obtain in this second case a luminious intensity of about 14 carcels, either 9·1 watts or 0·92 kilogrammetres per carcel, or 1·13 watts per candle, figures which do not greatly differ from those representing the luminious renderings of arcs of great power.

This regulator can, of course, work with higher intensities or with any intensity, but it is specially interesting from the point of view of the economic subdivision of the electric arc into small lights by means of simple and strong mechanism.*

## THE NATURE OF ELECTRICITY.

IN the *Electrical World* of April 23rd (writes Mr. Carl Hering) was published a communicatton from me in which, for the sake of discussion in the paper, I advanced an argument which appears to indicate that electricity is matter and not force.

In the two answers published May 7th† and 14th‡ I have been misrepresented, your correspondents having changed not only the meaning of the terms which I used, but even the terms themselves, and with this new and different interpretation, together with other uncalled for expressions, they have endeavoured to show that the original argument was absurd. Such an answer it is needless to say is neither creditable to the writers nor just and fair to me.

I was well aware of the fact that force and energy are not identical, and therefore when I said force I did not mean energy, or I should have been likely to say so. Your correspondents need only to refer to the absolute system, in which they will find that the "dimension" of force is $\frac{m\,l}{t^2}$, while that of work is force multiplied by distance, that is, $\frac{m\,l}{t^2} \times l$, and that of power is $\frac{m\,l}{t^2} \times \frac{l}{t}$. But even granting that everything is either energy or matter, instead of force or matter, the same argument may be used regarding the nature of electricity.

Force is *that which causes acceleration*, or, as Prof. Dolbear states it, the rate of change of momentum, which is the same thing. Energy of motion of a moving body is measured by the product of its mass and half the square of its velocity. In the absolute system mass is represented by $m$ and velocity by $\frac{l}{t}$ therefore

* This has been done at the Laboratory for Physical Researches at the Sorbonne.

† See ELECTRICAL REVIEW for May 20th and ‡ May 27th.

energy (work) would be $\frac{m\,l^2}{t^2}$, which is the same dimension as that of volt-coulombs or electrical energy (work.) In this connection it may be interesting to recall that an ohm is a velocity equal to 1,000 million centimetres per second. A short but clear discussion of these units will be found in the excellent little book by Fleming, "Short Lectures to Electrical Artisans," Chapter 5, and foot note on page 135.

These critics have made the mistake so commonly made, of confounding *electricity* itself, measured in coulombs, with *electrical energy*, that is, with volt-coulombs (work), and volt-ampères or watts (power). By reading my letter more carefully, they will find that I referred particularly to electricity and not to electrical energy, as no one doubts that the latter is energy and not matter. This very fact that a volt-coulomb is energy (work), which I believe is not doubted, would tend to indicate that coulombs by themselves cannot also be energy (work), otherwise volts would appear to be mere coefficients or numerals without any "dimension," but this, the absolute system shows, is not the case.

As to the term, matter, I have also been misrepresented. There is no reason whatever why the sense in which I have used the term "matter" should differ from the "certain definite meaning in physical science" which it has, and if your correspondents will consider this more carefully before they attempt to ridicule it, they will, I think, find that they have been mistaken. The reason that we are not yet able to weigh the ether is no proof that it can have no weight. It requires better proofs (which may already exist) than those hasty conclusions of your correspondents to show that ether is not material. It has been taught by what I thought good authority that ether *has* weight, and that, as nearly as I can recall it, a volume of ether as large as the earth weighs between 100 and 200 lbs., though I will not vouch for the correctness or the reliability of this last statement. The remark that it is "immaterial matter" can therefore hardly be tolerated.

According to the hasty conclusions of one of your correspondents, water would be "a form of energy" because it "does work" in a water-fall; for instance, I refer him to any primary book on mechanics. If he will read my first letter more carefully he will find that I am not guilty of making the "popular error." I am not aware that "electricity is readily transformed into heat, light, sound, &c." It is *electrical energy* (volt-ampères or volt-coulombs) but not electricity itself (as measured in coulombs) that may be transformed into other forms of energy. I may be mistaken, but at present I know of no case in which a coulomb of electricity can do any work except when at an electrical potential or pressure (volts), precisely as in the case of water without a pressure, chemical affinity, &c. It is the "volt" which appears to be consumed in doing work, not the ampère or the coulomb, as any one who has run arc lamps in series will know.

Regarding the argument advanced about the five storage cells, I need only say that if the correspondent will read my letter with more thought, he will, I trust, be able to see that this example does not meet the argument. According to his argument, if five water motors are driven in series (that is, by a single high pressure current of water) each one actuating a pump which discharges into a common tank, the water which has driven and passed through the motors and "did not stay there" is not "matter," because five times that quantity has been pumped into the tank.

In conclusion, it may be well to add that I profess to know as little about the nature of electricity as either of the correspondents. I did not *prove* that it is matter, as it may be quite possible that it is not; I merely advanced the argument as a "speculation in an idle moment" to "indicate the nature of the problem," and hoped to hear some interesting and good arguments to the contrary, but based on the argument as stated and not with all its terms changed and misinterpreted. The fact that the argument, as it is stated, has not yet been met or weakened, indicates that there may be some truth in it. If it can be *proved* that force and matter, or energy and matter, do not make up the universe, then the argument is based on incorrect premises. The statement that electricity may be ether was not an argument, but merely a suggestion, as will be seen from the first communication.

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Mr. N. H. Edgerton in the same journal writes: I wish to thank Professor Dolbear for his admirable illustration of the twisting rope, which will assist many to a better comprehension of the train of molecular vibrations, which we denominate electrical current, than they have ever had before, as well as for objecting to the reception of a theory which can only confuse and mislead.

The science had in its early days the "one fluid theory" and the "two fluid theory," comparable to the measles and chicken-pox of childhood. But, having gotten safely over these, in Heaven's name do not let us go backward and cover with a mantle of confusion and error the origin and operation of the most sublimely simple of all the great forces of nature by declaring it "matter." By so doing we should place ourselves on a par with the young man who, when he saw the electric light for the first time, was so carried away by his enthusiasm for it that he importuned the writer to furnish it to him at his house, saying; "I'll have my house lighted with *that stuff* if it costs *twenty dollars a barrel*."

If Prof. Dolbear will permit me I would suggest that "the difficulty of getting a mechanical idea of electricity" would be greatly lessened by taking into consideration the origin and directive tendency of the chain of vibrations which we call current, and to do this we must get at the cause of those vibrations. Let us take for our example a simple galvanic cell.

We shall find the surface of the oxidising electrode to be the base of operation or the starting point in the circuit, and the cause of its so being is that we have enveloped it with a substance which offers to every molecule on the exposed surface of the plate a stronger attraction than that which holds it in the metallic form. With a spring it passes into the saline state, setting up the crest of the first wave or vibration in the chain, and exposing its immediately consequent neighbour atom to the same attraction to which it succumbed. Thus follows an infinite number of vibrations or oscillations, each crest pointing outward from the oxidising electrode most probably because the rear of each molecule is protected by the mass in the plate, and the solicitation to change of condition comes from one side only. In this view of the case duality disappears and we have a conception of a continuous vibratory chain of molecules to which the Professor's twisting rope is a complete analogy.

In short, electricity is *the energy of molecular vibration*, and the cause of electricity is *any disturbance* of the *normal attraction* of *matter*, but not matter *per se*.

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## ECONOMICAL ELECTRICAL DISTRIBUTION.

IT has recently been the duty of the writer (Prof. J. Burkitt Webb, Stevens Institute of Technology), in the *Electrical World* to make some computations with regard to the most economical distribution of an electric current.

Problem: Let it be required to light a certain district having given the number of lamps and their positions, as well as the average "drop," loss of potential, or fall in the electromotive force allowable. Suppose also that the lights are so situated that there is no doubt as to the best location for the mains, sub-mains and branches, nor for the "distributing points" where the mains branch into sub-mains, or the latter into branches.

Were the case such as to admit of diagonal lines the problem might properly include the selection of the best course for the wires, which leads to some inte-

resting problems; but where highways have to be adhered to it is often clear that the wires must follow a certain course or its equivalent.

Following, therefore, the paths decided upon for the wires, let there be $n_1$, $n_2$, $n_3$, &c., lights at the respective numbers of feet from the dynamo station, $d_1$, $d_2$, $d_3$, &c. Let the current required for each light be $a$ ampères at $v$ (volts potential), and let the loss in the distribution be limited to an *average* fall of potential, or "drop," of $r$ per cent. of the total potential. Required the sizes of the wires needed.

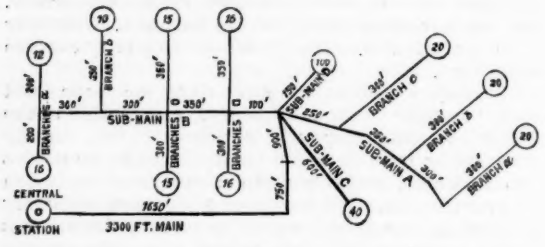



FIG. 1.

If the potential required at the lights be $v$ and the drop or fall of potential = F = $r$ per cent. of $v_0$, the dynamo potential, then

$$v = \frac{100 - r}{100} v_0;$$

or at the dynamo the potential is

$$v_0 = \frac{100}{100 - r} v$$

and the drop = F = $\frac{r}{100} v_0 = \frac{r}{100 - r} v$. (1)

This drop is for the average or "representative lamp," the distance of which from the station we must now find. Multiplying the number of lamps at each point by their distance, adding these products and dividing by the total number of lamps (a process analogous to finding the centre of gravity of the lamp system), we obtain the distance, D, of the "representative lamp," or the average distance of the lamps from the dynamo.

Thus putting

N = $n_1 + n_2 + n_3$ + &c. = the total number of lamps.

$$D = \frac{n_1 d_1 + n_2 d_2 + n_3 d_3 + \&c.}{N} = \frac{\Sigma (nd)}{\Sigma (n)} \quad (2)$$

The proper size of wire will be such as to allow of the specified drop in D feet, and the drop will be less (greater) for lamps nearer to (further from) the dynamo. This variation of potential at the lamps will be found by multiplying the drop per foot

$$f = \frac{F}{D} = \frac{r v}{D (100 - r)} \quad (3)$$

by the variation of the distance of each lamp from the average distance; thus, for a lamp whose distance is $d$, there will be an excess of potential

$$= \Delta v = (D - d) f = \left(1 - \frac{d}{D}\right) \frac{r v}{100 - r} \quad (4)$$

For lamps where $d$ is greater than D this, of course, becomes a deficiency of potential.

To find the sizes of wire needed we first find what would be required for the "representative lamp," D feet distant from the dynamo. The resistance, $h$, per foot (single) of such a wire will be

$$h = \frac{f}{2 a} = \frac{r v}{2 a D (100 - r)} \quad (5)$$

($f$ is the drop per foot of distance, but, there being both direct and return wires, $\frac{f}{2}$ must be used here), so that, by Dr. Matthiessen's standard of 13·6 ohms for 5,280 feet of $\frac{1}{16}$th inch copper wire, we have for the section, $j$, of this wire:

$$j = \frac{\pi \times 13{\cdot}6}{4 \times 16^2 \times 5280\, h} = \frac{\pi \times 136 \times 2\, a\, D}{32^2 \times 52800 \times r\, v} (100 - r) \quad (6)$$

If now the "main" is to carry the current for N such lamps, its section will be:

$$\text{Section of main} = N j; \quad (7)$$

that of "sub-mains" to supply $N_1$, $N_2$, &c., lamps:

$$\text{Sections of sub-mains} = N_1 j, \text{ \&c.}; \quad (8)$$

that of "branches" to supply $n_1$, $n_2$, &c, lamps:

$$\text{Sections of "branches"} = n_1 j, \text{ \&c.}; \quad (9)$$

the section of any wire being proportional to the number of lamps to be supplied.

Where there is a uniform fall of potential per foot, a main, sub-main or branch is in reality nothing more than a bundle of as many separate lamp wires as happen to run together made into one wire for convenience, and the section of any such larger wire is the sum of the sections of the single lamp wires, which it may be supposed to replace.

If all the lamps do not require the same number of ampères, then the formulæ produced are still true if we let $n_1$, $n_2$, &c., stand for the number of ampères required at each point, and N for the total number of ampères, and our representative lamp will then be a lamp requiring one ampère. $a$ will also stand for one ampère, and will, therefore, disappear from the equations.

As a practical instance of such a calculation, we give here the actual figures for lighting a portion of the suburbs of a town of almost 14,000 inhabitants, see fig. 1.

The numbers inclosed in circles indicate the number of lights supplied at each point.

The potential, $v$, required at the ends of the branches is 1,000 volts with $\frac{6}{100}$ ampère per lamp, and the average drop is not to exceed two per cent.

By (1) we have

$$F = \frac{2}{100 - 2} \times 1{,}000 = 20{\cdot}4 \text{ volts for the entire drop, or loss of potential.}$$

By (2)

$$D = \frac{1164850}{300} = 3{,}883 \text{ feet, as the distance of the representative lamp.}$$

(3) gives

$$f = \frac{20{\cdot}4}{3883} = 0{\cdot}0053 \text{ volts drop per foot.}$$

Applying (4) to the farthest and nearest lights to the central station, we have

$\Delta v$ = (3883—4550) × 0·0053 = − 3·5 volts (deficiency below 1,000 volts)

$\Delta v$ = (3883—3450) × 0·0053 = 2·3 volts (excess above 1,000 volts).

The resistance per foot of wire for the representative lamp is, by (5),

$$h = \frac{f}{2 a} = \frac{0{\cdot}0053}{0{\cdot}06 \times 2} = 0{\cdot}044 \text{ ohm.}$$

The section of the representative wire (single) will therefore be (6)

$$j = \frac{\pi\, 13{\cdot}6}{4 \times 16^2 \times 5280 \times 0{\cdot}044} = 0{\cdot}00018 \text{ sq. inches.}$$

For the main, sub-mains and branches, we shall therefore have, according to (7), (8) and (9), the following:—

| Wires. | No. of lights. | Single section. | Resistance per 1,000 feet. | Suitable gauge No. |
|---|---|---|---|---|
| Main ..... | 300 | 0·054 sq. in. | ·15 ohms | 2 |
| Sub-main A ..... | 60 | 0·011 „ | ·73 „ | 8 |
| „ B ..... | 100 | 0·018 „ | ·44 „ | 6 |
| „ C ..... | 40 | 0·007 „ | 1·1 „ | 10 |
| „ D ..... | 100 | 0·018 „ | ·44 „ | 6 |
| Smallest branch ... | 10 | 0·002 „ | 4·4 „ | 16 |
| Largest branch..... | 20 | 0·004 „ | 2·2 „ | 13 |

Should it be desirable to reduce the variation of potential, $\Delta v$, we may do so by using a proportionally greater "drop" for the main. Thus, to make $\Delta v$ one half, one third, or, in general, $m$ times what it is according to equation (4):—

$$\text{Put } \Delta' v = m \Delta v, \text{ and } f' = m f;$$

then by (4)

$$\Delta' v = (\text{D} - d) f';$$

from which we find for the sub-mains and branches the diminished drop per foot

$$f' = m f = \frac{m}{\text{D}} \times \frac{r v}{100 - r}; \qquad (10)$$

$$\text{and } \Delta' v = (\text{D} - d) m f = \left(1 - \frac{d}{\text{D}}\right) \frac{m r v}{(100 - r)}. \qquad (11)$$

Putting M for the length of the main, we have for the average diminished drop beyond the main

$$\text{F}' = (\text{D} - \text{M}) m f. \qquad (12)$$

$$= \left(m - \frac{m \text{M}}{\text{D}}\right) \frac{r v}{100 - r};$$

leaving for the main an increased drop

$$= \text{F}'' = \text{F} - \left(m - \frac{m \text{M}}{\text{D}}\right) \frac{r v}{100 - r}$$

$$= \frac{r v}{100 - r} - \left(m - \frac{m \text{M}}{\text{D}}\right) \frac{r v}{100 - r}$$

$$= \left[1 - \left(m - \frac{m \text{M}}{\text{D}}\right)\right] \frac{r v}{100 - r}, \qquad (13)$$

which will give for the main an increased drop per foot

$$= \frac{\text{F}''}{\text{M}} = \frac{\text{D} - m \text{D} + m \text{M}}{\text{M D}} \times \frac{r v}{100 - r} \qquad (14)$$

This will require for the representative lamp 2 M feet of wire of resistance

$$= \frac{\text{D} - m \text{D} + m \text{M}}{2 a \text{M D}} \times \frac{r v}{100 - r} \qquad (15)$$

and 2 (D − M) feet of wire of resistance

$$= \frac{m}{2 a \text{D}} \times \frac{r v}{100 - r}. \qquad (16)$$

We shall also have:

$$\text{Section of main} = \text{N} \frac{\text{M}}{\text{D} - \text{M D} + m \text{M}} j \qquad (17)$$

$$\text{Sections of sub-mains} = \frac{\text{N}_1}{m} j, \text{ \&c.} \qquad (18)$$

$$\text{Sections of branches} = \frac{n_1}{m} j, \text{ \&c.} \qquad (19)$$

Suppose that in the example above given we wish to diminish $\Delta v$ to one-third of its value as above calculated, making it therefore − 1·2 volts and 0·8 volts.

According to the previous discussion we have:—

| Wires. | No. of lights. | Single section. | Resistance per 1,000 ft. | Suitable gauge No. |
|---|---|---|---|---|
| Main ... ... ... | 300 | 0·048 | ·17 | 2 |
| Sub-main A... ... ... | 60 | 0·033 | ·24 | 4 |
| „ B... ... ... | 100 | 0·054 | ·15 | 2 |
| „ C... ... ... | 40 | 0·021 | ·37 | 6 |
| „ D... ... ... | 100 | 0·054 | ·15 | 2 |
| Smallest branch ... ... | 10 | 0·006 | 1·47 | 12 |
| Largest branch ... ... | 20 | 0·012 | ·73 | 8 |

This evidently increases considerably the weight of copper required, but as the sizes are not large there is no objection on the score of cost.

To allow for extensions the main may be No. 1, which will also reduce the total drop, and, to secure uniformity, the sub-mains may be run of No. 3 and the branches of No. 8 wire.

It will be noticed that although No. 3 is less than the calculated size for sub-mains, B and D, yet the lamps supplied by D are less than the average distance from the station, so that with No. 2 wire they would have too high a potential; also B branches after 100 feet, so that its total resistance made of No. 3 will be less than if of No. 2 for 100 feet, and of properly diminishing section the rest of the way, and therefore the variation of potential at the extreme lights may still not exceed $m \Delta v$.

By admitting such a slight variation in potential as we have just discussed, the advantages of a uniform system of wiring may often be secured; if, however, it be required to so wire a district that the potential at the various points of delivery of the current shall be exactly the same, it may be done by suitably varying the sizes of the wires used for sub-mains and branches. We will discuss a case of such wiring.

PROBLEM: To deliver $a_1$, $a_2$, $a_3$, &c., ampères of potential, $v$, at the respective distances, $\text{N}_1$, $\text{N}_2$, $\text{N}_3$, &c., by means of a main M feet long and several sub-mains, all diverging from the end of the main. It is of no use here to make the supposition that each lamp or set of lamps is wired direct, and that these direct wires bundled together form the mains, as in the preceding discussion, because, owing to the difference in the distances, the drop per foot would not be the same in all the wires; and therefore the uniting of several wires in one would change the distribution of the current and of the potential. We shall have recourse to the calculus to find the minimum weight of wire.

To make the nature of the problem clearer, we present first a

SIMPLE CASE.—Let a main, M, divide into two sub-mains, N′ and N″ long, both supplying $a$ ampères of potential $v$, as in fig. 2.

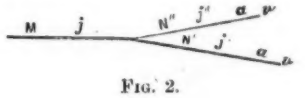



FIG. 2.

Evidently the same fall of potential must occur along N′ and N″; therefore their sections must be proportional to their lengths or

$$\frac{j'}{\text{N}'} = \frac{j''}{\text{N}''} \qquad (20)$$

Putting again F for the whole fall of potential and letting $m$ F = the fall on the main, we shall have for the drops per foot on main and sub-mains respectively:

$$f = \frac{m}{\text{M}} \text{F}$$

$$f' = \frac{1 - m}{\text{N}'} \text{F} \qquad (21)$$

$$f'' = \frac{1 - m}{\text{N}''} \text{F}.$$

And the resistances per foot:

$$h = \frac{f}{2 \times 2 a} = \frac{m}{4 a \text{M}} \text{F}$$

$$h' = \frac{f'}{2 a} = \frac{1 - m}{2 a \text{N}'} \text{F} \qquad (22)$$

$$h'' = \frac{f''}{2 a} = \frac{1 - m}{2 a \text{N}''} \text{F}.$$

Putting for $\frac{\pi \times 13{\cdot}6}{4 \times 5280 \times 16^2}$ the symbol $c$

we have

$$j = \frac{c}{h} = \frac{4 a \text{M} c}{m \text{F}}$$

$$j' = \frac{c}{h'} = \frac{2 a \text{N}' c}{(1 - m) \text{F}} \qquad (23)$$

$$j'' = \frac{c}{h''} = \frac{2 a \text{N}'' c}{(1 - m) \text{F}}$$

as the sections of the wires for any value of $m$, which values agree also with (20).

The volume of copper, V, required will, therefore, be

$$V = M j + N' j' + N'' j'' \qquad (24)$$

$$= c\left(\frac{M}{h} + \frac{N'}{h'} + \frac{N''}{h''}\right) = \frac{2\,c\,a}{F}\left(\frac{2\,M^2}{m} + \frac{N'^2 + N''^2}{1-m}\right)$$

To find the minimum value for V we place

$$0 = \frac{d\,V}{d\,m} = \frac{2\,c\,a}{F}\left(-\frac{2\,M^2}{m^2} + \frac{N'^2 + N''^2}{(1-m)^2}\right); \qquad (25)$$

which gives

$$\frac{m}{1-m} = \frac{\sqrt{2}\,M}{\sqrt{N'^2 + N''^2}}. \qquad (26)$$

This leads to a geometrical relation between the drops in the main, and sub-mains, as shown in fig. 3.

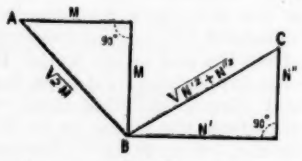



FIG. 3.

By proportioning the wires so that

$$\frac{\text{Drop in main}}{\text{Drop in sub-main}} = \frac{A\,B}{B\,C}, \qquad (27)$$

the distribution will be accomplished with the least weight of wire.

We will now discuss a more

GENERAL CASE.—Let the main, M, divide into any number of branches, $N_1$, $N_2$, $N_3$, &c., which are to carry, respectively, $a_1$, $a_2$, $a_3$, &c., ampères, as in fig. 4, and furnish it at a potential, $v$, with a total loss of potential of F.

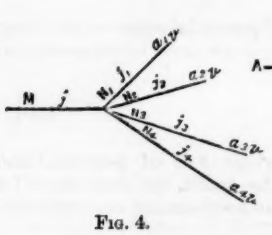


FIG. 4.

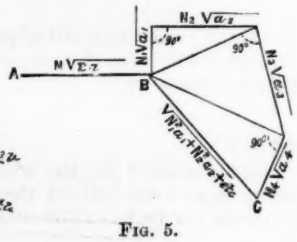



FIG. 5.

Following a similar course of analysis we get the following equations :

$$\frac{j_1}{a_1 N_1} = \frac{j_2}{a_2 N_2} = \frac{j_3}{a_3 N_3} = \&c. \qquad (20')$$

$$f = \frac{m}{M} F \qquad (21')$$

$$f_1 = \frac{1-m}{N_1} F$$

$$f_2 = \frac{1-m}{N_2} = F$$

&c., &c.

$$h = \frac{f}{2\,(a_1 + a_2 + \&c.)} = \frac{f}{2\,\Sigma\,a} = \frac{m\,F}{2\,M\,\Sigma\,a}$$

$$h_1 = \frac{f_1}{2\,a_1} = \frac{1-m}{2\,a_1 N_1} F$$

$$h_2 = \frac{f_2}{2\,a_2} = \frac{1-m}{2\,a_2 N_2} F \qquad (22')$$

&c., &c.

$$J = \frac{c}{h} = \frac{2\,c\,M\,\Sigma\,a}{m\,F}$$

$$J_1 = \frac{c}{h_1} = \frac{2\,c\,a_1 N_1}{(1-m)\,F}$$

$$j_2 = \frac{c}{h_2} = \frac{2\,c\,a_2 N_2}{(1-m)\,F} \qquad (23')$$

&c., &c.

The volume will then be :

$$V = \frac{2\,c}{F}\left(\frac{M^2\,\Sigma\,a}{m} + \frac{N_1^2\,a_1 + N_2^2\,a_1 + \&c.}{1-m}\right)$$

and we shall have :

$$0 = \frac{d\,V}{d\,m} = \frac{2\,c}{F}\left(-\frac{M^2\,\Sigma\,a}{m^2} + \frac{N_1^2\,a_1 + N_2^2\,a_2 + \&c.}{(1-m)^2}\right).$$

$$\frac{m}{1-m} = \frac{M\sqrt{\Sigma\,a}}{\sqrt{N_1^2\,a_1 + N_2^2\,a_2 + \&c.}}$$

The geometrical construction is shown in fig. 5.

The wires must therefore be proportioned so that

$$\frac{\text{Drop in mains}}{\text{Drop in sub-mains}} = \frac{A\,B}{B\,C} \qquad (27')$$

as in the simple case, equation (27.)

The application of a low potential system of say 200 volts to the distribution of electricity over an area requiring such lengths of mains as occur in the example cited above, would make it necessary to allow at least 10 per cent. "line drop" in order to properly limit the amount of money invested in copper conductors. With a large "line drop" the variation of potential may, by the use of the first method, be too great to insure the desired uniformity of illuminating effect among all the lamps of a district.

Under such circumstances, the calculation of the minimum amount of copper required must be made in accordance with the principles illustrated in the second problem considered above.

## PRACTICAL ELECTRICAL MEASUREMENT.

By J. SWINBURNE.

(*Continued from page* 10.)

### CALIBRATION OF VOLT AND AMMETERS.

IT is very strange that so many makers pay so little attention to the accurate calibration of their instruments. There are instruments in the market which are well designed and well made, but are useless, or worse than useless, because the calibration is bad and the graduation wrong. Perhaps the reason is that many makers are engineers rather than electricians, and look upon calibration as an intricate scientific operation which cannot be performed successfully without expensive apparatus and enormous trouble ; or perhaps they think accuracy of calibration of little importance, as most engineers have no means of checking instruments. If a buyer complains that two voltmeters got from different makers do not agree, he is told by each that the other's voltmeter is incorrect.

Very great accuracy is not at all necessary for practical electric light work, but a voltmeter should certainly be correct within one-half per cent. throughout its scale. It is doubtful if there is at present one instrument in the market which is within this limit ; though one or two makers are now awakening to the necessity of accurate calibration. Ammeters are not quite so important, but the cost of maintenance of installations is enormously increased by lamps being run too dull or too bright ; and until engineers have voltmeters which are correct and electric governors to insure the right electromotive force, incandescent lamp illumination will be seriously handicapped. The idea that any compound dynamo preserves sufficiently constant electromotive force for incandescent lamps is a mere delusion.

Voltmeters are best calibrated by means of a standard cell. Various standard cells have been proposed by

different writers, but the Latimer Clark seems to be much the best, and, for the present, it will be assumed that one is used. In order that the Clark cell should give its standard electromotive force it is necessary that it should give no current, otherwise it suffers from polarisation; it is therefore balanced against the fall of potential over a resistance through which a current is flowing, the current being supplied by another source. This is known as the Poggendorff method.

The Poggendorff method was originally a disposition by which the electromotive force of one cell was balanced against that of another by means of resistance boxes or rheostats; one of the cells had, however, to supply the current. This arrangement was devised in 1841. About 20 years later Du Bois Reymond made a modification of the opposing principle, in which the rheostat was replaced by a stretched wire. Mr. Latimer Clark has also worked at the subject more recently; and the wire and slide arrangement for comparing the electromotive force of two cells without taking the current from either of them is known as Clark's potentiometer. The term potentiometer has lately come to denote merely the wire and slide arrangement of Kirchhoff's bridge.

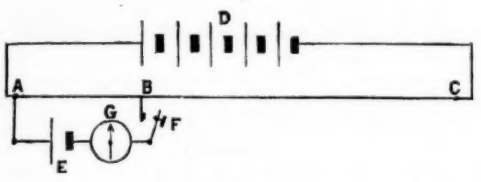



FIG. 16.

There are very many ways of arranging the standard cell and slide, one is shown diagrammatically in fig. 16. D is a battery which causes a current in the wire, A, B, C, there is therefore a gradual fall of potential between A and C. E is a standard cell, it is in series with a galvanometer, G, and the key, F, which is connected with the sliding contact, B. If B is slid along till there is no deflection of the galvanometer when the key is pressed, the fall of potential between A and B is equal to the electromotive force of the cell, and exactly balances it.

The electromotive force between A and B is thus measured against the electromotive force of the cell when the cell is not giving any current. If the electromotive force of the cell is known, and the resistance of A, B, is known, the current through A, B, can be got at once. If the resistance of A, C, is also known, the electromotive force between A', C, can be also calculated. It is not necessary to know the exact resistances of A, B, and A, C, all that is needed is the ratio of the resistances. If A, C, is a wire of uniform resistance, so that any inch of it has the same resistance as any other inch of it, it is only necessary to know the relative lengths of A, B, and A, C. A, C, is therefore generally a wire stretched over a scale.

Suppose the cell gives 1·435 volts and the resistance of A, B, is 10 ohms, or, say, its length 10 divisions, and of A, C, 700 ohms or divisions, there will be a difference of potential of 100·45 volts between A and C, and of 99 between B and C. If a voltmeter had been arranged in shunt to A, C, B having been moved to balance E while the voltmeter was in circuit, the electromotive force of the voltmeter would have been determined in comparison with the standard cell.

In practice, the battery, D, is made up of little secondary cells capable of giving the highest electromotive force ever wanted. Little Planté cells will do for this purpose, as only very small currents are necessary. To avoid the expense and trouble of connections to each cell, the lead may be bent as shown in fig. 17, so that the reduced plate of one cell serves as the peroxide plate of the next.

Messrs. Sowerby, of Gateshead, make little pressed glass cells which are admirably suited for this sort of work and are very inexpensive. The cells are made up in batteries of 10 or other convenient numbers. A little mineral oil is floated on the top of the dilute acid to avoid spray. This not only prevents the acid spray from corroding the connections and from attacking any metal work that may be near, but is also valuable as an insulator, as it tends to creep over the edges and down the sides of the cells.

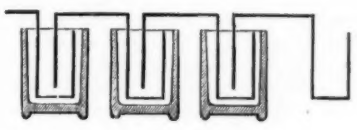


FIG. 17.

The greatest care must be taken to insulate not only the cells but every separate piece of apparatus used in calibration work. Even those accustomed to laboratory work are apt to make serious error by neglecting to insulate everything properly. Many of the troubles of leakage may be avoided by arranging the apparatus in such a way that small leaks do not matter; but it is generally safest to insulate everything as well as possible to begin with, so that it is not necessary to depend on ingenuity in subsequent disposition. If the charging dynamo gives lower electromotive force than is needed for calibrating, the cells are coupled in parallel for charging and in series for discharging. Fig. 18 represents a convenient arrangement for charging and discharging. Suppose the dynamo gives 60 volts, the circuit is led through a resistance to the mercury cups, *a* and *b*, which are holes in an ebonite

FIG. 18.

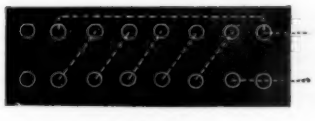


FIG. 19.

FIG. 20.

slab filled with mercury. The cells in groups of 20 are connected with one set of terminals to the mercury cups, *c*, *d*, *e*, *f*, *g*, *h*, and the others to the cups *i*, *j*, *k*, *l*, *m*, *n*. The cups, *o*, *p*, are connected to the wires to the voltmeters and rest of the apparatus. The slab has three lids which have wires passed through so that one makes the connections as shown in fig. 18 for charging, one disconnects the dynamo and puts the cells all in series for discharging giving 240 volts, fig. 19, while the third puts, say, three sets in series, two sets in parallel, giving 120 volts and twice the current, fig. 20. It is advisable to disconnect the dynamo altogether when the cells are in use, as there always are ground leaks in the dynamo frame which might give trouble. The various wires and mercury cups should also be well insulated.

Cells with plates made of plain sheet lead take a little time to form well enough for constant use. A few holes punched in them, and filled with red lead, will give them enough storage capacity at once. This arrangement of the cells needs resistance to reduce the electromotive force, so that any desired electromotive force may be obtained on the voltmeter to be calibrated. The resistance may consist of 30 coils of wire in 10 lots of 1 ohm, 10 of 10, and 10 of 100 ohms.

Each set is connected to a dial with a handle. The dial may have the 10 contacts arranged round the circumference with an arm and central contact. This form of switch is very liable to get out of order, as the central contact goes wrong unless very well made. The writer has devised a switch to overcome this difficulty. In this there is no central contact, as the circuit is right across the cross-bar, which makes contact on each end.

FIG. 21.

The segments are arranged so that the coils are short-circuited one after the other. Of course the cross-bar is turned through half the circle only to short-circuit out all the resistance. An ebonite handle is fixed to the cross-bar to insulate it from the hand. The electromotive force on the voltmeter may also be regulated by putting many or few of the cells in circuit. To do this, the slab and mercury cup arrangement is used for charging only, and for discharging the cells are coupled to two switches like those just described for the resistances. One switch puts the cells into or out of circuit one at a time, while the other does so 10 at a time. The switch must have a double contact and resistance arrangement, otherwise if the moving contact piece makes contact with one section before it leaves the other, the cell or the 10 cells between will be short-circuited for a moment, or permanently if the switch is left in that position. If, on

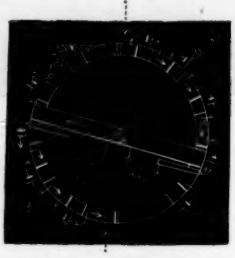


FIG. 22.

the other hand, the segments are so far apart that the contact piece leaves one before it touches the next the circuit will be broken for a moment and there will be sparking. Fig. 22 is a diagram of a switch with 10 cells and resistance contacts. For sets of 1 cell the resistance should be about 8 ohms, for sets of 10 cells about 80 ohms.

(*To be continued.*)

## THE EFFECT OF THE SUN'S RAYS ON SELENIUM.

AT a recent meeting of the Swedish Royal Academy of Sciences Prof. E. Edlund, the celebrated Swedish electrical *savant*, read a paper on the effect of the sun's rays on selenium, describing the most recent experiments made with that substance on this point, particularly in Sweden, of which the following is a *resumé*.

Some twelve years ago it was announced to this society that the metal selenium, discovered by Prof. Berzelius, had a greater electrical conductivity when exposed to the rays of the sun than in a dark chamber. This applies to the crystalline form of selenium, whereas in the amorphous state it is a bad conductor of electricity. This remarkable peculiarity of selenium has, since, many times been the subject of research in several countries, and particularly among Swedish *savants*, the results of which are, that it is has been discovered that the effect of the light varies under different kinds of light, and that it is, moreover, so powerful that the electrical resistance under favourable conditions, in bright sunshine, is not more than six or seven per cent. of its magnitude when the metal is in a dark chamber. During the last few years these researches have been resumed by electrical *savants*, who have succeeded in demonstrating some other important electrical peculiarities possessed by this metal.

The selenium is melted on a metal disc, with which it can form some chemical combinations, and is distributed in a layer, the thickness of which is only two or three hundredths of a millimetre. On this layer of selenium a gold leaf is pressed, so thin in texture that the sun's rays can penetrate it and reach the layer of selenium. Now, if this composition be exposed to the influence of the sun's rays, and its electrical resistance be tested by leading an electrical current from the gold leaf to the metal disc below, it will be found that sometimes the conductivity will decrease to one-third per cent. of what it is when the element is placed in the dark. By this method the sensitiveness of selenium to the light has been found twenty times greater than was formerly known to be the case. Moreover, it has been demonstrated by these researches that the resistance of the selenium depends upon the direction of the electrical current, the resistance being fifteen to twenty times greater if the current runs from the gold leaf to the metal disc than *vice versâ*. This phenomenon, which was demonstrated in a dark chamber, seems to indicate that the chief obstacle to the continuity of the current must be sought in the point of transmission between the gold leaf and the selenium layer, or between that of the latter and the metal disc, as any difference in the resistance offered by the selenium itself, whether the current runs in one or the other direction, is impossible. This view is also supported by the circumstance that the resistance was dependent upon the strength of the current as well as upon the electromotive force of the battery.

Another discovery, also of interest and importance, was made. If the gold leaf and the metal disc, between which the selenium layer is placed, were connected by means of a wire attached to a galvanometer, it showed that the electric current began to circulate as soon as the gold leaf came under the influence of the sun's rays, and that even the beam of the moon on the light of a lamp made the element active. This being a fact, we may ask whether the light at the points of contact between the selenium layer and the metals with which the latter is surrounded effects some chemical change whereby the formation of a current is caused, or whether the active force possessed by the light is immediately transformed into an electric current? As the current commences at the moment the element is subjected to the light and ceases the moment the latter is removed, the last mentioned solution seems really the most natural. This being as it may, we have by these experiments obtained a dry pile, a pile without acids, which may lead to the discovery of other secrets.

## FRIEDLAENDER'S PORTABLE ELECTRIC LAMP.

THIS electric portable lamp, which is of great simplicity and, so the inventor claims, suited for everybody's use, has been constructed and a patent applied for by Mr. Albert Friedlaender, electrician, of Berlin.

The incandescent lamp, strongly protected by a German silver reflector and glass, is attached to an ebonite battery box, 7 inches by 4 inches. This receptacle is divided inside into six cells, each of which represents one element. The electrodes (zinc and carbon) are immersed by turning a knob attached to the outside.

FIG. 1.
The Friedlaender Safety Lamp.

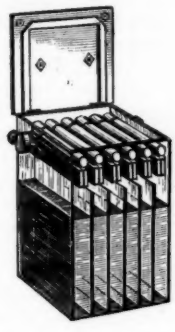


Fig. 2.
The Battery (inner construction when not in action).

When the light is turned off, the electrodes rest in a horizontal position, therefore there is no consumption in the battery when out of action. The exciting fluid is a new solution of chloride of zinc and bichromate of potash, acting, it is said, perfectly steadily and without any fume or smell. The chemicals can be bought of any druggist at the cost of less than 6d. per charge, sufficient for three hours' light. Re-charging is very nearly as simple as with any ordinary petroleum lamp. The lid being unscrewed, the decomposed solution is poured away and a fresh charge filled in. The carbons are of a highly conductive kind, specially prepared.

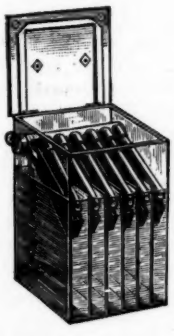


FIG. 3.
The Battery (inner construction when in action).

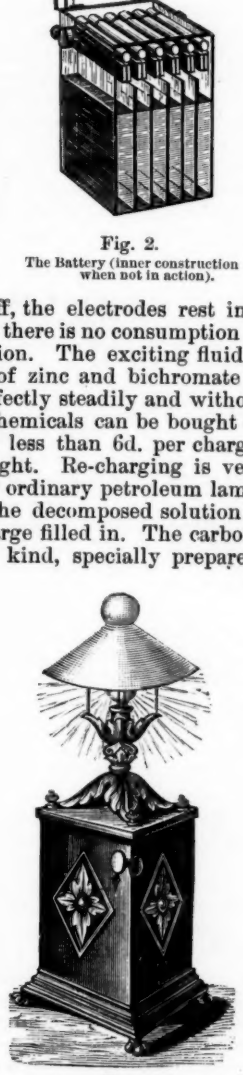


FIG. 4.
Ornamental Lamp.

The zinc rods have to be renewed from time to time, but this can be done by anyone in less than five minutes; the whole set of fitted zinc rods costs 6d. The lamp can always stand in readiness with battery charged, so as to have a light at any moment by simply turning the knob; from that knob the light can be regulated from 1—3 C.P., and from three to four hours' duration. The mechanism cannot get out of order. The small incandescent lamp has only half the life of an ordinary Edison lamp. Mr. Friedlaender is making some such lamps of a more ornamental character for the sleeping room.

## THE SCHOOL OF ELECTRICAL ENGINEERING, HANOVER SQUARE.

A VERY successful *conversazione* was held at this well-known school on Friday, July 1st, there being a large attendance of visitors; the latter, who were received in the entrance hall (which was prettily decorated with flowers) by Madame Drugman, were much pleased with everything they saw. The whole building was well and steadily lighted from forty-two accumulators in charge of the pupils of the school, the engine and dynamos for charging the same being kept running during the evening as part of the exhibition. It should be mentioned that the whole of the work in the school, even to the stoking of the boiler fire, is carried out by the pupils and teaching staff, not from motives of economy, but in order that everything may be thoroughly practical.

Amongst the exhibits were the following:—

Corridors:—Apparatus illustrating land and submarine telegraphy, including an artificial line, a "Mirror" receiving instrument, a siphon recorder, a Wheatstone fast-speed transmitter, &c. A telephone line, fitted with M. de Jongh's microphone carbon transmitter, requiring no adjustment whatever (exhibited by Messrs. Mourlon & Co., Brussels). Elementary Class Room:—Portable miner's electric lamp, kindly lent by J. W. Swan, Esq. Apparatus manufactured and exhibited by Messrs. Nalder Brothers & Co., former pupils of the school. Pitkin's portable electric lamp for mines, powder magazines, and general use. Apparatus illustrating the dispersions of dust and smoke by electricity, exhibited by Messrs. F. E. Becker & Co. Half-horse-power electric motor, manufactured and exhibited by Messrs. Immisch & Co. Mechanical engineering models, including one specially made for this school by Mr. W. W. Beaumont, lecturer on steam engineering. Specimens of submarine cables, and of animals found growing thereon when they have been taken up for repairs. Diagrams illustrating the distribution of temperature in the great ocean basins, as ascertained by H.M.S. *Porcupine*, *Challenger*, &c. Advanced Class Room:— Electric lamps of various kinds. Small electric motors. Switchboards for electric light and for telephones;— Photometer Room. Tables arranged for various electrical tests and measurements, including the localising of faults in submarine cables. Historical submarine telegraphic apparatus (presented by the late Mr. C. F. Varley). Collection of telephonic apparatus. Drawings of instruments and machines by students, &c. Basement:—Newly-erected steam engine and boiler. Gas engine. Forty-two accumulator cells by the E.P.S. Coy., and by Messrs. Drake and Gorham. Different types of dynamos, lathe, tools, &c. Upstairs Class Rooms:—Quadrant electrometer and apparatus employed in instruction. Various tests arranged in work. Experiment for showing the apparent increase of resistance due to self-induction. Cable Room:—Telegraphic and telephonic apparatus, communicating with that in the corridors and in other parts of the building, under the charge of Mr. J. G. Stone, instructor.

During the evening a selection of music was performed. Also a series of lantern demonstrations was given by Mr. H. D. Wilkinson (senior instructor), showing land and submarine telegraphy, cable laying and repairing, deep sea fauna, &c., and by Mr. E. C. Rimington (lecturer), showing electric lighting, Swan's miner's safety lamp, transmission of power—the lantern being in charge of Mr. E. T. Carter, instructor.

Amongst the visitors present were Mr. J. W. Swan, Mr. J. N. Shoolbred, Prof. S. P. Thompson, Mr. F. H. Webb, and many apologies were received from others for unavoidable non-appearance.

The managers, Mr. W. Lant-Carpenter, B.Sc., and Mr. Leon Drugman, are to be congratulated on the success of their entertainment, which, we fancy, must have opened the eyes of many as to the capabilities of the establishment, which now ranks amongst the foremost of the technical schools of this country.

## NOTES.

**The Electric Light in the Royal Navy.**—On the occasion of the forthcoming naval review, which is to take place in the presence of the Queen and other distinguished visitors at Spithead, the whole of the vessels both in the roadstead and in the harbour are during the evening to be brilliantly illuminated, chiefly by means of electric search lights and incandescent lamps. The spectacle will probably be one of the prettiest which has ever been witnessed afloat. All the arrangements are to be made by the officers themselves.

**The Electric Light on Ryde Pier.**—Having fully persuaded themselves of the value of electricity by the success of their railway propelled by that means, the directors of the Ryde Pier Company have adopted small incandescent lamps for the purpose of illumining the carriages. The dynamos and other machinery used to work the railway have been utilised to supply current for the lamps at very little additional expense.

**The Electric Lighting Act.**—One day last week the *Daily News* contained an announcement that "we understand" that Mr. Hugh Watt would that evening move a resolution, the terms of which follow :—"That the Electric Lighting Amendment Bill introduced by Lord Thurlow in the House of Lords having been deprived of its most important provision by the decision of the committee of that House, and thus rendered useless for the purpose for which it was intended, no measure short of a repeal of the Electric Lighting Act, 1882, and the substitution therefor of legislation rendering it possible to supply electric light to the public with a fair prospect of remunerative returns will be of any benefit to the electric lighting industry, and as that Bill has to a very large extent destroyed the growth of the industry in this country, and driven the export trade into American hands, it is desirable that the aforesaid Act be forthwith repealed, and those engaged in this new industry (which now employs nearly £50,000,000 of capital, and over 50,000 workmen in America) be freed from the fetters of legislation, which have proved of so disastrous a character." The resolution was not moved, probably because no opportunity occurred.

**Electric Lighting in the City.**—At the fortnightly meeting of the Commissioners of Sewers on Tuesday, the clerk submitted a notice of Messrs. Bircham and Co., on behalf of the South Metropolitan Electric Supply Company, that application is intended to be made under the Electric Lighting Act, 1882, in the ensuing session, for a Provisional Order for power to supply electricity for lighting and other purposes in certain streets and places within the City. It was referred to the Streets Committee.

**Electric Lighting at Bournemouth.**—Messrs. Mortimer, Shepherd & Co. have completed their experiments for the lighting of the pier at Bournemouth by three different systems of electric light. First, on Easter Monday last, "Pilsen" arc lamps were set up, and continued to burn for 16 nights, when they were removed. The Thomson-Houston system was next tried, and continued burning for the six nights following. Then all the cables, supports, &c., were removed, and the circuits were arranged on the pier for lighting an incandescent lamp of 16-candle-power in each of the existing gas lanterns. This system began on Jubilee night, June 21st, and ended on Monday, June 27th. A powerful arc lamp was during the whole time kept steadily burning nightly on the tower of the Royal Exeter Hotel. It is intended to at once proceed with the lighting of business and other premises in the town. Messrs. Bright and Williamson, of the Arcade, have their establishments already fitted for the new illuminant. Messrs. Mortimer, Shepherd & Co, are raising a syndicate among the townspeople, in order to secure as much local interest in the work as possible.

**Lighting Tenders.**—The lighting inspectors of Ilford, Essex, are advertising for tenders for the lighting of about 120 public lamps with gas, paraffin oil, or electric light for twelve months. Tenders should be forwarded by the 11th inst. to Mr. A. Sherman, 1, Oakfield Road, Ilford.

**Theatre Lighting in Brussels.**—M. Gérard offers for a sum of 122,000 francs, payable in case of success, to light up the hall of the Theatre "De La Monnaie" with 250 glow lamps, generating the current at the city gas works and transmitting it to La Monnaie by means of apparatus which he has patented and which allows a current to be conveyed to a distance of 6 kilometres. He proposes also to fit up at the theatre a battery of accumulators which in case of accident can supply the light for five hours.

**Proposed Electric Lighting in Paris.**—M. Gaulard proposes the installation of five works placed outside the ramparts, each of 1,000 horse-power. From each of these, five 100-horse-power machines will feed five circuits with a current of 30 ampères and 2,500 volts, which will be transformed into a current of 10 ampères and 50 volts by means of secondary generators placed near the arc lights. Each circuit will comprise 150 Jablochkoff candles, and will have a length of six kilometres. The five other machines of each works will supply stations to be established in the different wards of Paris.

**Exeter Telephone Exchange.**—This exchange, which was started just recently, already shows signs of rapid development, twenty-one orders for connections having been received from leading tradesmen in the city. Before the end of the year it is hoped that this number will be increased to fifty. A trunk line from Plymouth to Exeter is on the *tapis*, so as to enable the commercial relations between the two places to be conducted with greater facility than heretofore.

**Communication with Lightships.**—In the House of Commons on the 30th ult., Sir E. Watkin asked the Secretary to the Board of Trade whether the Government intended to make progress with the Bill to amend Lloyd's Act, 1871, in order to enable Lloyd's to connect lighthouses with the mainland, and especially to connect Tory Island with the mainland of the north-west coast of Ireland. Baron H. de Worms replied that the Bill to which the hon. baronet referred was one to confer upon Lloyd's certain powers with respect to sites for fog signal stations, and it was intended to proceed with it, but the details of the measure were still under consideration.

The Committee appointed to consider the subject of electrical communication between light vessels and the shore has concluded its inquiries, and will report in favour of an 18 months' trial of the system adopted in connection with the Sunk lightships off Harwich, with a view to the general adoption of the system if it proves satisfactory.

**Telegraph Superintendents.**—Mr. Dillwyn asked the Postmaster-General on Friday last week whether, in view of the great increase of the number of telegraphic messages sent in consequence of the reduction to the sixpenny tariff for such messages, whereby the duties of the telegraph superintendents had become much more onerous than heretofore, it was intended to take their case into consideration with the view of granting them a correspondingly increased remuneration. Mr. Raikes said the subject was one which required a good deal of examination, and was also one in regard to which he wished to reserve full liberty and discretion.

**New Cable.**—We understand that the Telegraph Construction and Maintenance Company is now manufacturing 2,000 miles of submarine cable. We hear also that it is to triplicate a line which has already two cables in working order, so our readers can amuse themselves by guessing its ultimate destination.

**The Hall Effect in Metals.**—Measurements have lately been made by Messrs. A. von Ettingshausen and W. Nernst, upon the Hall effect manifested in different metals. They have found that tellurium far surpasses bismuth in its power, hence they think that the Hall effect is connected with the thermo-electric properties of the metals. The effect is least in tin. Taking this as unity, the effects in other metals is relatively as follows: platinum, 6; copper, 13; gold, 28; silver, 21; palladium, 29; cobalt, 115; iron, 285; nickel, 605; carbon, 4,400; antimony, 4,800; bismuth, 252,500; tellurium, 13,250,000. The sign of the effect is positive in the case of cobalt, iron, steel, antimony, and tellurium, also lead, zinc, and cadmium. It is negative in all the others.

**Electrically Played Organs in Theatres.** — Organs, if used in theatrical performances, are placed in the scenes, so that the organist cannot follow the movements of the conductor, and hence experiences a certain difficulty in accompanying a chorus. This inconvenience has been suppressed at the theatre of Nantes. Thanks to the use of electricity proposed by M. Debierre, the keyboard will be placed in the orchestra whilst the pipes, &c., remain in the scenes. The stops will be regulated by electric action.

**The Telegraph Jubilee Dinner.**—The arrangements for this dinner on July 27th proceed apace, and a distinguished company may be expected to attend. Amongst those who have been invited as guests and have accepted the invitation are the Postmaster-General (the Rt. Hon. Cecil Raikes, M.P.), Lord Onslow, Sir Lyon Playfair, Sir Algernon Borthwick, Sir Frederick Bramwell, Sir Douglas Galton, Mr. J. Norman Lockyer, Mr. John Pender, Mr. G. B. Bruce, and Mr. J. C. Macdonald.

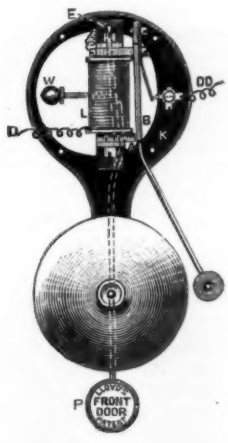
**Electrical Work in Mexico.**—A Manchester paper is giving information respecting "The Trade of the World," "from special telegrams and sources of news all over the world," and in an article, headed "Contracts in Mexico," the following passages occur: "Telegraph wire comes almost entirely from America. This is a point which should be looked into. The Chicago Insulating Company does a good trade in glass insulators. With regard to the telephone, it has been introduced into almost every town. Many places have been connected with the nearest political or commercial centre, even where that centre is from 25 to 30 leagues off. The Blake instrument is the most popular, but there would be no difficulty in introducing any superior apparatus. The plan to adopt would be to get permission to make telegraphic and telephonic experiments simultaneously, on one of the federal lines by means of the same wire. The federal system does not possess the copper galvanised wire which alone will conduct for great distances, but still very good experiments might be made. Before long the Mexican Government will have to double and perhaps triple its present line. There is an opening for the electric light all over the country, for coal is too dear to make the manufacture of gas at all practicable, except in great centres like Mexico, Puebla, and Guadalazara, and even there it is very dear and very bad."

**Rat-Catching by Electricity.**—A Birmingham (Conn.) electrician has a new rat-trap, which, it is said, works admirably. He attaches a piece of meat to one pole of a dynamo machine, which can only be reached by a rat standing on a plate, which serves as the other pole. Report says that no rat has yet got the meat, but many have reached for it, and the inventor is rewarded for his ingenuity with a large collection of dead rats.

**Electric Fire Alarms.** — At the meeting of the Metropolitan Asylums Board on Saturday, subject to the approval of the Local Government Board, the tender of Mr. Julius Sax, of Bloomsbury, was accepted (upon the recommendation of the Leavesden Asylums Committee) to provide and fix electric fire alarms through the asylum at a cost of £187.

**Electricity and Tramways.**—On Monday the Select Committee of the House of Commons, presided over by Mr. Stevenson, resumed the consideration of the Bill for confirming a provisional order granted by the Board of Trade authorising the use of electrical or any mechanical power (other than steam power) on the tramways of the West Metropolitan Tramways system. At the adjournment of this committee, in the early part of last week, the Metropolitan Board of Works had raised the question that the Board of Trade had no power to grant any such provisional order to the tramway company, but if such a power existed it rested with the Metropolitan Board and not the Board of Trade. By order of the committee, the Board of Trade appeared this morning, and the question was argued at great length. The committee ultimately overruled the contention of the Metropolitan Board, and decided that the Board of Trade had jurisdiction in this matter. Upon this decision being given, counsel for the Metropolitan Board declined to take any further part in the proceedings, and intimated that the question would be raised in the House on the third reading. The Bill thereupon passed the committee stage unopposed.

**The Boss Electric Indicating Bell.** — A useful novelty in domestic signalling has just been brought before our notice for improving the means of communication either in large buildings or in private houses. The "Boss" has but one coil, the magnet of which attracts the armature of the bell and, at the same time, that of a pendulum, the disc of which bears in luminous paint the name of the room from whence the signal has been transmitted. The centres cannot jump out of the bearings, and the pendulum can be regulated by a connterweight to work from one to thirty




minutes, and its simplicity precludes the probability of it getting out of order. It can be made very cheaply, and it is one of the best things we have yet seen of its kind in the market. The "Boss," which is protected under the patent of Mr. Lloyd, is made as in the cut or with the working parts under the gong. Of course single coil bells are no longer novelties, neither are pendulum indicators, but the combination of the two together with the knife-edge bearings of the latter, seems to form a very useful addition in the domain of electric bells. The inventor recommends his improved sealed Leclanché battery for use with the bells, stating that they are specially constructed to last from five to seven years without attention; our own experience, and that of others, is that sealed batteries are an utter delusion, and that they last but a very short time, even if the work they have to do is very small.

**Statistics of Gas Making.**—The capital employed in gas manufacture in the United Kingdom amounts to £60,432,000, the gas made per annum to 92,637 million cubic feet, and the coals carbonised to produce this quantity of gas to 9,387,000 tons.

**Effects of Magnetism on Strength of Iron and Steel.**—Mr. N. Marshall, of Dayton, O., describes in the *Electrical World* some experiments which he made two years ago in regard to "the effect of magnetism on the strength of iron and steel." He says :—"These experiments, with which the greatest care was taken to obtain trustworthy results, were conducted mainly as follows : Several long uniform rods of iron and steel were cut into short lengths, and each alternate length was magnetised to saturation. While thus magnetised, they were broken in a testing machine, as were also the unmagnetised pieces. The object of treating alternate pieces of the rods was to avoid any error that might arise from inequalities in different parts. Although I do not now recall the exact figures of the experiments, the magnetised pieces invariably showed a slightly higher tensile strength than the unmagnetised pieces, thus proving conclusively that *the effect of magnetism on iron and steel is to slightly increase its strength.*"

**The Submarine Cables Conference.**—The International Conference for the protection of submarine cables, which reassembled on the 1st inst. at the Ministry of Foreign Affairs at Paris, separated on Tuesday. It was decided to sign a protocol fixing May 1st, 1888, as the date on which the Convention of March 14th, 1884, should come into force. This is, however, subject to the condition that the five signatory States which have not yet adopted the laws prescribed by article 5 of the Convention shall by that time have taken measures calculated to ensure the carrying out of the international arrangement.

**An Electric Club for Boston.**—Not to be behind Chicago and New York, the electricians of Boston have determined to establish an electric club in that city.

**Lea's Patent Globe.**—Messrs. Fowler, Lancaster and Co., of Birmingham, are manufacturing a new globe for enclosing incandescent electric lamps. The following are some of its special features :—Both the globe and its cover are made of glass ; the globe has an elastic connection with the cover, and can be removed or replaced instantaneously ; neither the globe nor the cover has any metallic rim to obstruct the light ; the globe is designed so that the maximum amount of light is obtained without the incandescent filament being directly visible ; the globe is dust proof, thereby preventing the lamp from becoming obscured by dust, and avoiding the risk of breaking the lamp in cleaning ; the flexible cord is held firmly by an insulating material which relieves the electrical connection of the weight of the globe ; the globe can be even roughly handled in cleaning without danger of damaging either the lamp or fittings, and it can be fitted either with the usual socket or loop lamp holders, or with any special form.

**Portable Electric Lamps.**—Mr. Friedlaender has sent us a description of his new electric lamp, which will be found illustrated in our present issue. It is difficult to see the advantages of this apparatus over, say, that of Schanschieff, unless it is in the question of cost. We shall hope to illustrate some of the last-named inventor's apparatus in our next.

**Lighting the Parliament Houses.**—In the House of Commons the other night, when the question of Supply was under debate, Dr. Tanner advocated the further extension of electric lighting in the buildings.

**Electrical Distribution.**—A small book on the subject of electrical distribution by alternating currents and transformers, compiled by Mr. Rankin Kennedy, will shortly be published. As our readers will remember, Mr. Kennedy has recently communicated a number of papers on the subject to this journal, and those papers form a large part of the pamphlet. It is the intention of the author to enlarge and extend the work so that it may form an accurate history and treatise, but in the meantime it serves to show the position in which the practical science of the subject stands at this date.

**A New Reversible Battery.**—A correspondent writes that he has received a description from a friend on the Continent of a new battery which the latter has constructed. He has translated this description and forwarded it to us. We publish it for what it is worth :—"The electrodes of this battery are very light, they do not disintegrate or deteriorate, and by their nature are almost indestructible. When the battery is exhausted it is regenerated simply by passing a current, and there is no need to renew the liquid, which can last for years without addition of any chemicals. No acid in the liquid, no smell, no creeping salts, no gases. The battery may be hermetically sealed and transported to any distance, either abroad or in the country, where it will render valuable services for the lighting of private residences. Each element by its construction represents a cell containing its liquid and its plates, and its plates being very thin and quite close to one another in an electrolyte composed of very little water, it will be easily understood that this compact accumulator can give under a weight of about 60 lbs. (all included) 25 volts and 10 ampères during 12 hours. There is no local action and no buckling. This new accumulator does not require formation. When the current passes the battery is charging. E.M.F. open circuit 1·877 ; great constancy. The plant and manufacture of such a battery requires a comparatively small capital and no skilled labour is needed. The advantages of this accumulator are great, especially for the traction of tramways, lighting of railways and domestic lighting, and for all purposes where the weight and bulk of lead batteries are an objection. The price of a battery giving 25 volts and 10 ampères (in round figures) during 12 hours = 4 horse-power hour is about £13 16s. ; manufactured on a large scale, the cost price will be less, and in this country would be something like £11."

**Battery Zincs.**—Messrs. Fredk. Braby & Co. are prepared to supply specially prepared and refined zinc battery plates for electrical purposes, in all thicknesses and shapes, with or without copper tongues, at the shortest notice and at the lowest prices.

**Extremes Meet.**—It is not an uninteresting fact to note that as Cooke and Wheatstone's telegraph instruments were used on the first telegraph line in this country, so is Wheatstone's automatic still the leading apparatus in Britain.

**Historical Telegraph Instruments.**—One of the five-needle instruments of Cooke and Wheatstone is in the historical collection at South Kensington Museum.

**The "Oerlikon" Dynamo.**—Mr. B. H. Thwaite, C.E., is exhibiting the Oerlikon dynamo in the Machinery Court of the Liverpool Exhibition. This dynamo is the patent of Mr. C. E. L. Brown, of Oerlikon, and is much admired on the Continent. It is stated to give an electrical efficiency of 98 per cent., and a commercial efficiency of 96 per cent., without sparking at the brushes or overheating. Further particulars respecting a series of tests carried out with these dynamos have already been published in the REVIEW. Another machine is to be placed in the Manchester Exhibition.

**Technical Education.**—The inaugural meeting of the National Association for the Promotion of Technical Education was held on Friday last at the rooms of the Society of Arts, Adelphi, for the purpose of appointing an executive and forming a programme tor the association. Lord Hartington, in opening the proceedings, said their object was not so much to stimulate public attention in this great question as to consider from a practical point of view the channels into which such interest ought to be directed. Sir Lyon Playfair, M.P., moved that the association be formed, that Lord Hartington be invited to become president, and the following gentlemen vice-presidents :—Lord Granville, Lord Ripon, Lord Rosebery, Lord Spencer, the Bishop of London, Mr. Broadhurst, M.P., Professor Huxley, Sir John Lubbock, M.P., Mr. Mundella, M.P., Sir Lyon Playfair, M.P., Sir B. Samuelson, M.P., Professor Stuart, M.P., Dr. Sullivan, Sir R. Temple, M.P., and Professor Tyndall. Mr. John Morley, in seconding the motion, said the time for further inquiry had gone past, and the time had arrived when they could no longer with wisdom, or even with safety, delay the movement they that day commenced. The resolution was carried unanimously. Sir J. Lubbock, M.P., moved the appointment of an executive committee, which was carried ; as was a motion, made by Mr. Mundella and seconded by Lord Rosebery, that those present be invited to join the council.

**British Association.**—The local executive committee of the Manchester meeting of the British Association met on the 30th ult. under the presidency of Mr. Alderman Thompson. The finance committee reported that the guarantee fund now amounted to £10,345. The evening entertainments committee reported that the Mayor of Manchester (Mr. Alderman Harwood) had invited the members and associates to a *conversazione* in the Town Hall on Tuesday, September 6th, and a *soiree* offered by the executive committee of the Royal Jubilee Exhibition, had been fixed for Thursday, September 1st. Efforts to secure the presence of eminent foreign men of science had met with great success ; of those invited nearly a hundred had promised to attend, including Americans, German, French, Russians, Belgians, and men of other nationalities. In physics, chemistry, and biology the attendance is expected to be very large. Through the kindness of the Postmaster of Manchester, arrangements have been made for branch post and telegraph offices in the reception room at Owens College, and the Lancashire and Cheshire Telephonic Exchange Company has undertaken the telephonic arrangements. The lecture to working men on the evening of Saturday, September 3rd, by Prof. G. Forbes, F.R.S., will be on the electric light, and the Manchester and District Edison Electric Light Company will carry out the experimental illustrations in connection therewith.

**British Electricians in America and the Jubilee.**—A dinner which was arranged by a committee, upon the initiative of Messrs. Martin and Wetzler, of the *Electrical World*, to celebrate, in New York, the 50th anniversary of Queen Victoria's accession and of the establishment of telegraphy in England, took place at Martinelli's, 136, Fifth Avenue, on the 20th ult. The committee consisted of Messrs. G. G. Ward (chairman), Leo Daft, T. C. Martin, Samuel Insull, Wm. Maver, and W. M. Callender (hon. secretary and treasurer). About 40 were present, and the dinner was a great success. Good speeches were made ; cablegrams in felicitous terms came from Sir Wm. Thomson, Mr. W. H. Preece, and others in Europe and North and South America. "Her Majesty the Queen," "President Cleveland," "The Electrical Profession." &c., were toasted enthusiastically, and "God Save the Queen," "The Star Spangled Banner," and other airs were sung, and a new song composed for the occasion by Mr. G. H. Guy, and written by Mr. T. C. Martin, entitled "England is where Britons be," was received with ringing applause. Altogether, private advices inform us, a very joyful time was spent.

**The Telegraph in the Highlands.**—The following is a petition adopted by the Highland and Agricultural Society last month in regard to an extension of the telegraph in the Highlands :—"That this Society was first instituted for the purpose of improving the Highlands of Scotland, and it still takes a deep interest in all that can benefit these parts of the kingdom ; that your petitioners have heard with satisfaction that there is a movement at present to have telegraphic communication extended on the west coast, and humbly beg to impress on you the great desirability of such a step ; that in the interest of the fishermen on the west coast of Scotland, your petitioners beg earnestly to impress on you the great benefit they would derive from the arrival of steamers being made known by telegraph, so as to have their fish ready for shipment ; that your petitioners are aware that full particulars of the advantages to be derived from telegraphic communication with the west coast have been already laid before you in a memorial from the inhabitants, a copy of which has been sent to this Society, and in which it heartily concurs. Your petitioners therefore humbly beg that you will give the subject your favourable consideration, and grant their request."

**Gas and Electricity.**—Speaking at the annual meeting of the members of the Gas Institute, held at Glasgow last week, Mr. Foulis, the president, said :—The most timid shareholder no longer fears electricity as a possible extinguisher, although this system of lighting is also making progress, and with so many minds engaged in its development, it must progress both in efficiency and economy. In both of these respects gas lighting is still well in advance. Our duty is not in any way to impede the development of electric lighting, but rather to render it every assistance, while at the same time we strive to cheapen and improve the mode of lighting in which we are more immediately interested. We have to thank the introduction of electric lighting for much of the progress that has been made in recent years in improving the lighting power of gas, in creating a demand for more brilliant illumination, and stimulating invention to supply the demand. A few years ago it would have been considered impracticable to develop much more light from a foot of gas than can be obtained from a properly-constructed Argand or Batswing burner. Now there are are many burners in actual use giving double this amount of light, and we have not reached the end of this development.

**Fire in an Electric Light Works.**—The factory at Newark of the United States Electric Lighting Company, which works under the patents of Mr. Edward Weston, were almost completely burnt down on Friday, the 17th ult. That part of the works devoted to the manufacture of lamps suffered most. The instruments in the laboratory were saved, and the dynamo department was only partially destroyed.

## OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

**H. C. Bull & Co., Limited.**—An agreement of 25th ult., filed on 27th ult., between this company and Wm. Edward Sendey, of 2, Waterloo Villas, New Brighton, Cheshire, provides for the purchase by the company of the invention, apparatus and premises referred to in another agreement of even date, the purchase consideration being 40,000 fully paid shares of £10 each.

**Elieson Electric Company, Limited.**—An agreement of 3rd May between Alfred Bracher on behalf of the Electric Locomotive and Power Company and A. Venner for this company, provides for the taking over of the business of the former company. The new company will satisfy and discharge the debts, liabilities and obligations of the old company, and will issue three new shares credited with £5 per share paid up in respect of each fully paid share held in the old company, and in respect to the shares partly paid up, will

issue fully paid new shares, proportionately to the amount paid to the old company. Registered office, 31, Liverpool Street, E.C.

**Portable Electric Lamp and Power Syndicate, Limited.**—The statutory return of this company, made up to the 15th ult., was filed on the 4th inst. The nominal capital is £9,000 in 45 shares of £200 each. Nine shares have been allotted, and £175 per share has been called and paid up. Registered office, 41, Coleman Street.

**New Electric Light Syndicate, Limited.**—The statutory return of this company, made up to the 21st ult., was filed on the 28th ult. The nominal capital is £16,000 in £10 shares; 1,200 shares have been allotted and are considered as fully paid up. Registered office, 2A, West Street, Finsbury, E.C.

**Indian and Oriental Electrical Storage and Works Company, Limited.**—At a meeting of this company, held on the 30th ult., an account was presented showing the manner in which the winding up has been conducted and the property of the company disposed of.

**Woodhouse and Rawson Electric Manufacturing Company, Limited.**—The annual return of this company, made up to the 23rd ult., was filed on the 28th ult. The nominal capital is £100,000 in £10 shares; 4,728 shares have been taken up and the full amount has been called and paid thereon.

**Northern District Telephone Company, Limited.**—The annual return of this company made up to the 27th ult. was filed on the 2nd inst. The nominal capital is £200,000 divided into 30,000 ordinary shares of £5 each issued as fully paid, and 5,000 preference shares of £10 each, the whole of which have been issued. On 2,500 preference shares the full amount has been called, and £6 per share has been called upon other 2,500 preference shares. The calls paid amount to £40,000.

## CITY NOTES, REPORTS, MEETINGS, &c.

### United Telephone Company, Limited.

THE seventh annual general meeting of this company took place at the City Terminus Hotel on Tuesday, under the presidency of Mr. James Brand, the chairman. The directors' report presented to the meeting appeared in the REVIEW last week, Mr. Thomas Blaikie, the secretary, having read the notice convening the meeting,

The Chairman said: Gentlemen, I will commence the few remarks I have to make with one or two references to the accounts. You have all had a report, and I trust you will consider it sufficiently clear to speak for itself; but there are one or two points I will allude to. The capital expenditure has been £41,500; of this sum £36,000 has been used for the development of the metropolitan system, and £5,000 has been spent for telephones in use in our subsidiary companies distributed all over the country. Then, as to our revenue and expenditure, our metropolitan system, which, as you are aware, is now entirely separated from the rest of our business, shows an income of close on £90,000, being an increase of close on £8,000. This is a substantial figure, but would have been disappointing to us did we not know that our progress had been retarded by the snowstorm in December last. To earn this increase we have spent about £2,000 less in working expenses. In addition to our expenditure for working expenses, we have spent £11,000 in repairs and replacements, and have put about £5,000 to suspense account for liabilities which are possible to turn up. Our reserve is now over £102,000 by the addition of over £4,000 from exceptional sources, and £1,200 has been set aside for depreciation of instruments in use all over the country. As to the dividend, the amount available for the whole year is £62,236. Of this you have received an interim dividend at the rate of 10 per cent., and we now propose to make this up to 13 per cent. for the year by a further payment of £35,804, and to carry forward to next year £4,053. The comparative statement we have placed at the end of the accounts will enable you to compare easily each year since the formation of the company. You will notice that our metropolitan system is now debited with £11,000 for royalties. It is now divided into 10 separate sections, each section having an efficient staff to develop, canvass, and work it. This division has for the moment caused some extra expenditure, as we have hired extra stores, &c., in most of the districts, so that all materials may be at hand for whatever work there is to do. But our extra expenditure will be more than repaid by greater efficiency. By this time next year we shall have 14 divisions, and the carrying out of the work for forming these divisions and working is even more difficult and intricate than the opening up of telephonic systems in the same number of separate towns. When I last had the pleasure of speaking to you I told you that we were completing the renewal of our two largest exchanges and one central trunk exchange with the most perfect switchboards in existence, and that shortly we hoped to show our subscribers a much improved working. In October last we had got our exchanges into a high state of efficiency, and our calls at the end of December had reached the high figure of 42,000 in one day, or equal to 84,000 telegrams. We were congratulating ourselves, and beginning to feel that our subscribers were well pleased, when the great snowstorm took place on Boxing night, and in a few hours upset the labour of the whole year. This snowstorm hit us in two ways. It not only upset our system, which was working so well, but prevented us for nearly four months canvassing for new subscribers, and stopped all the plans for further development which we were prepared to carry out during the spring months; and it was necessary to devote the whole of our energy to putting our old subscribers once more in connection, rather than to try to get fresh customers, who we knew could not be joined up. A good deal of annoyance was expressed and vexation caused by the apparently long delay that occurred in the replacement of our system. Many people thought that our work could have been done quicker, and ought to have been done quicker. But I can assure you that we did everything that seemed possible to us, and used every good man that was available at the time. You must remember that we did not stand alone in our misfortune. The storm was general all over the country, and every great railway as well as our subsidiary companies was suffering, and it was impossible to get trustworthy and skilled men at a moment's notice to fulfil the great demand for this special labour that had arisen. We did our best to overcome our troubles, and I believe we have succeeded fairly well. Our calls have again reached the position they were in when the disaster occurred. While we suffered much from this snowstorm, I trust we have gained somewhat by the lessons we have learned. We have secured the services of a very efficient consulting engineer, Mr. John Tomlinson, who has superintended the replacement of our wires, poles, and derricks. We hope we have found out our weak points, and have mended them in such a way that we are advised will minimise the effects of any future trouble. We should be glad, of course, if we could so arrange our wires as to avoid any further mishap; but the state of the law forces us to do work in one way that we would often like to do in another. If the recommendations of the Committee of the House of Commons of 1885 could be carried out to even a modified extent, we could overcome many difficulties without the least prejudice to the public, and certainly all danger from a breakdown of our wires would be done away with if we were allowed to run them in a straight line along the houses or streets, crossing the streets at right angles. This would avoid all the necessity of long spans, which is our principal weak point. I am glad to tell you that no accident whatever occurred to the public during all the time of the snowstorm. I may tell you that the telephone enterprise of Great Britain now comprises 212 exchanges, 19,000 subscribers, and 225,000 messages per day average, with a gross income of £325,000, and about 30,000 miles of wire. There has been no litigation of any consequence in regard to the patents since the decision of the Court of Appeal in favour of the company in the action against Messrs. Bassano & Slater, of Derby, about 12 months ago. There was talk of an appeal in that case by the defendants to the House of Lords, but the time for notice has expired, and no notice of appeal has been given. As might have been expected, a good deal of ingenuity has been exercised by various people in attempts to construct good working telephones which do not come within the scope of the company's patents, and if the paragraphs which appear from time to time in the newspapers are to be accepted, these gentlemen are doing great things. But, singularly enough, they seem never to get beyond newspaper paragraphs. As soon as they make a decent instrument they seem to come within the company's patents, and when they keep outside them they make instruments of no real commercial utility. We will not fail to maintain in the future, as in the past, the valuable patent rights secured by so much labour and expense, but we think we are best protecting our property by allowing many of these ingenious efforts to fail by their own weakness rather than by bringing the formidable and expensive artillery of the law to bear upon them in every case. The Chairman concluded by moving that the report and accounts be adopted.

Mr. J. S. Forbes, seconding the motion, said after the very lucid statement of the chairman, he need not trouble the meeting with many remarks. There was just one thing he would like to draw special attention to, however, which was the very large sum by which the working expenses of the year had been increased in consequence of the action of the board in reference to the snowstorm, which unparalleled calamity was a very great strain on the chairman and the administration generally. The shareholders would observe that the board had charged the amount, £15,777, boldly and at once to the revenue account, instead of extending it over a long period. He thought it was a matter for great congratulation that, notwithstanding the heavy burden on the expenditure, they were enabled to declare legitimately the same dividend as last year. In reference to this subject he could not sit down without specially alluding to the great services of the

chairman on the morning of the storm. At enormous personal risk and inconvenience he came to town with his sons and tackled the difficult problem of the situation in that bulldog manner which distinguished his character, and which was one of the main sources of the success of this undertaking. The managing director, and in fact the staff generally, also deserved enormous credit for the manner in which they met the difficulties of that trying time.

Mr. F. J. Butcher enquired whether the directors had considered the policy of having underground wires for at least the trunk lines. In conversation with subscribers and other people he had found that there was a great deal of difficulty in persuading new people to join because they thought it very likely that the lines would be interrupted for two months. If only the trunk lines even were laid underground there would be less liability of interruption in consequence of snowstorms. There had been some outcry against overhead wires, upon the ground that they were dangerous, and it was hardly likely that there would be any difficulty in obtaining powers to lay underground lines.

Mr. William Abbot said he was quite ready to admit that the board had had a very bad time of it during the snowstorm, but he could not shut out from his mind the fact that they were likely to have snowstorms again, and if they were constantly to be depending for their revenue upon the will of providence in regard to snow that would form a very serious element in forming an estimate of the value of their investment. He was very glad to hear that the board had called in to their aid an efficient engineer. The chairman had stated that they were now beginning to find out their weak places. It was always desirable for companies as well as individuals to find out their weak places, and now that they were finding out theirs he had no doubt that they would speedily supply a remedy. He must correct a statement which the chairman had made to the effect that the working of the exchanges gave perfect satisfaction. As a subscriber to the system, and one of the earliest, he could safely say it did nothing of the kind. A large number of shareholders were subscribers, and they had a very great deal indeed to complain of with reference to the working of the system. They must not for a moment imagine that he wished to throw cold water on the system. He believed they had a veritable gold mine, second only to the telegraphic system. But they expected that the board should leave nothing undone in order that the development of the telephonic system in London should make rapid strides during the lifetime of the present proprietors. Referring to the comparative statement in the report, he said that for the past year the smallest amount of increase in the gross receipts was shown of any year since the company was established. They must blame the snowstorm for a great deal of the loss in net revenue, but they could scarcely attribute the small amount of gross profit to the same cause. Perhaps it could be explained away, but there was the fact. In the metropolitan district the gross revenue was £95,655 in 1886, and £100,899 in 1887. Why had the gross receipts not increased to a greater extent? Was it because they did not make any special effort, as the chairman had said, because they did not feel justified in obtaining new subscribers whilst the system was disorganised? If so, that would be a perfect answer to his criticism. There was a feeling out of doors that there was a want of vigour in the adminstration of the company. One of the causes of this charge of want of vigour lay in the fact that nothing whatever was done to extend the usefulness of this system outside of London. He knew that on the Continent a trunk line had been established between Paris and Brussels, and he believed that that trunk line was doing remarkably well. Why should they not do something similar? Was there any bar to connection between London subscribers and subscribers in Manchester and Liverpool? If there was, let the shareholders know what it was, and they would be satisfied. The sooner they had communication with the subscribers to the exchanges of the subsidiary companies, the better it would be for this company. In July last he made a daring proposal to the chairman, to the effect that some effort should be made to separate the shares of the subsidiary companies held by this company to a large extent, and that those shares should be placed in a trust and distributed amongst the shareholders, the control of the company being still vested in the board. The chairman said he would think over the proposal, and he (Mr. Abbott) wished to know to what extent his thoughtfulness had carried them.

Mr. Henriquez, referring to the snowstorm, said he thought the board ought to strengthen the supports that carried the wires. He was an engineer, and knew from experience that in New York they had more serious snowstorms than here, yet he had not seen any wires falling about the streets there in clusters.

Dr. Brown said many of the British houses were not constructed in a sufficiently solid manner for fastenings to be made to them securely. They would have to rebuild all the houses if they were to fix the wires so that such a storm as occurred last year would not break them.

Sir Julian Goldsmid suggested to the directors that they should reconsider the articles of association, under which they received a certain per centage of the profits by way of remuneration. At present they were receiving £5,000 amongst seven directors, and that would be increased if the dividend rose. He believed in men being paid well for any work they did, but he thought this system was a bad one and was very sorry to see it being introduced into London business. He himself was a director of a company which had a capital of four millions, and that company divided only £5,000 amongst ten directors. Sir Julian also said there was a strong opinion that the directors did not do enough to extend the benefits of the system, which were very large, through the suburbs of London.

The Chairman, replying to the criticisms made, said the question of capital had nothing to do with the amount of remuneration which the directors should receive. When the United Company was started it had no capital at all. The capital was made by himself and a few others who were devoted to the thing, and the affair was much more difficult to manage then than it was now. He had not gained by the company half as much as he could have earned at any other business, and the sum he now received per annum, with the extended profits, was not a large sum considering the work he had done and had got to do. He did not think this method of payment a bad one. They staked their money and their time before the company got into working order; he devoted himself to it and to nothing else, and staked a large amount of money in it long before he received a shilling. Now it was beginning to pay, the directors would profit in proportion. With regard to extending the system to the suburbs, they had done their utmost to get to different places, but the difficulties were enormously great. By much persistence they had pushed lines through to different places, but they could not get the subscribers. He had got a line through to Tooting, and a call-room at Clapham and another at Tooting, but for the past two years they had been unable to get wayleaves. Dr. Brown had complained of the length of the wires crossing the streets. He was quite right in saying the spans were too great, but, unfortunately, they could not help themselves.

Dr. Brown: The Government should help us.

The Chairman, continuing, said there was a recommendation in 1885, but there had been so many great questions before Parliament and the Government since then, that the little telephone had been neglected. In reply to Mr. Henriquez, he said it was not so much that the poles were weak as that the roofs were not strong enough. In Glasgow, Aberdeen, and other towns in the North, they built the houses much stronger, and consequently the telephone did not suffer so much from the storms there. With regard to Mr. Abbott's proposal, he said at the last meeting that the directors had considered it, but they did not think it was a good plan. He did not think it would be a plan which would make the shares of the United Company more valuable to change the manner of their control over the subsidiary companies. As to long-distance lines, he did not know exactly what the laws were on the Continent, or whether they had so many difficulties as they had in this country. This he did know: they had made all kinds of experiments, had spent a good deal of money in making experiments, and no doubt they would succeed ultimately, but at present he would be wrong if he said that, under any existing circumstances, or under any circumstances likely to exist, they were likely to get commercial communication—and by that he meant practical communication—with Manchester. If they could get a free line, a line free of railways and telegraph lines and other matters of induction, then they would be able to communicate. They were doing what they could in the matter. He hoped they might be able to give a better account at the next annual meeting. They expected to be at Tilbury in two months' time. They were now out at Tooting, at Croydon, Clapham, Kensington, Hammersmith, and other places, but they had not yet met with much success as the result of their efforts. With regard to the revenue, he thought he had made it clear in his speech that when the snowstorm broke down their system, for four months they made no attempt to obtain new subscribers. He was sorry to hear that they did not get great satisfaction from the service. He, at any rate, thought the service was greatly improved at the end of last year, and that the fact was shown by the increase in the number of communications. There must always be dissatisfaction, but that would not prevent them from doing their best to improve matters. In answer to other questions, the Chairman further said that the patents would last for 4½ years longer. The danger of overhead wires looked much greater than it really was. They had never had an accident yet. They would be very glad to put the wires underground if it were practicable, but he was not sure that they would get efficient working in the streets as they were now. In the new streets and boulevards great subways were being constructed, and if these were general their work would be greatly simplified. Practically, he did not think underground wires had proved very successful where they had been tried, not, at any rate, with such a large system as theirs. There were many difficulties, and even in the underground railway they had found faults here and faults there, and in some places the rats had eaten off the insulating material from the wires. The directors would, however, be very glad to consider any suggestions which the shareholders might make, and those which had been made that day, including that of Sir Julian Goldsmid, would receive their best attention.

Mr. Edward Dwyer Gray, M.P., a member of the board, defended the principle of paying the directors by results, but said that if they decided to adopt underground instead of overhead conductors they need never fear that the directors' remuneration would be increased beyond what it was at present, As an instance of the difficulties the company had met with in trying to extend the system, he said they wanted to get to Reading some time ago when Mr. Shaw-Lefevre was Postmaster-General. That gentleman being then member for Reading, they thought he might probably help them. There was room on the railway at the time for their wire, but, although a public undertaking had been given in the House that where facilities existed they should not be refused them, the Post Office declined to grant them permission to run

wire to Reading, because they said at some future time they might require all the wayleaves along that line of railway, and they could not give them one. Mr. Gray concluded by pointing out the difference between the snow which falls in New York and that of which we have experience in England, and the greater danger of the latter to the wires.

The resolution was then put and carried unanimously.

The Chairman (Mr. Brand), Mr. J. S. Forbes, and Mr. J. B. Morgan, the retiring directors, were re-elected, some discussion taking place upon the subject of Mr. Morgan's remuneration, dissatisfaction being expressed that he, as managing-director, did not give the whole of his time to the service of the company. It was explained, however, that Mr. Morgan gave more time than he agreed to give, and that arrangements had been made to obviate any difficulty arising from his temporary absences from London; his remuneration last year was about £2,600.

Messrs. Quilter, Welton & Co,, and Messrs. Price, Waterhouse and Co., the auditors, were re-elected, and the proceedings then terminated with a vote of thanks to the chairman.

**The Eastern Telegraph Company, Limited.**—Subject to final audit, the accounts show, after placing £48,000 to reserve fund, a balance available for dividend sufficient to pay the fixed dividend of 3s. per share, being at the rate of 6 per cent. per annum on the preference shares, and a final dividend of 2s. 6d. per share, with a bonus of 1s. per share, tax free, on the ordinary shares, making with previous payments on account a total dividend of 5¼ per cent. on those shares for the year ended March 31st. In reference to the exchange of the company's Four per Cent. Mortgage Debenture stock in place of the Five per Cent. Debentures, due August 1st, that the time up to which the Five per Cent. Debentures may be deposited at the office is extended to July 16th.

## TRAFFIC RECEIPTS.

**The Cuba Submarine Telegraph Company, Limited.** The number of messages passing over the lines of this company during the month of June was 3,615, estimated to produce £2,750, against 3,377 messages, producing £2,767 in the corresponding month of last year. The receipts for the month of March, estimated at £3,650, realised £3,727.

**The West India and Panama Telegraph Company, Limited.** The estimated receipts for the half-month ended the 30th June are £2,921, as compared with £2,881 in the corresponding period of 1886. The February receipts, estimated at £5,844, realised £5,832.

**The Western and Brazilian Telegraph Company, Limited.** The receipts for the week ending July 1st were £2,540, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

**The Direct Spanish Telegraph Company, Limited.** The estimated receipts for the month of June were £1,563, against £1,522 in the corresponding period of last year.

**The Great Northern Telegraph Company, Limited.** The receipts for June, 1887, £27,600; from January 1st to June 30th, 1887, £127,120; corresponding months, 1886, £124,560; and of 1885, £142,840.

**The Brazilian Submarine Telegraph Company, Limited.** The receipts for the week ending July 1st amounted to £3,961.

**The Eastern Telegraph Company, Limited.** The receipts for June amounted to £45,426, and to £45,100 in the corresponding month of 1886.

**The Eastern Extension, Australasia and China Telegraph Company, Limited.** The receipts for June amounted to £35,138, and to £38,894 for June, 1886.

# PROCEEDINGS OF SOCIETIES.

## The Society of Telegraph-Engineers and Electricians.

AT the ordinary general meeting on May 26th a paper was read by Profs. W. E. AYRTON and JOHN PERRY on "The driving of dynamos with very short belts."

When fast-speed machines, such as dynamos, are driven in the usual way by belting, there is a certain waste of power in overcoming the friction that is set up between the driven spindle and its bearings by the tensions necessary to be given to the two sides of the belt to produce the required grip on the small driven pulley. This waste of power is usually kept small by using a long belt and putting the dynamo at a considerable distance from the large driving pulley, and thus obtaining a large angle of contact of the belt with the small driven pulley. But such an arrangement is very inconvenient to employ on board ship or in the guard's van of a railway train or elsewhere, when the space is confined, and a short belt would always be employed were it not that the small angle of contact of the belt with the driven pulley, that would be produced if the small pulley was put close to the large driving one, would necessitate the tension on the belt being large. And this large tension would cause considerable pressure on the bearings, leading to a considerable waste of power in overcoming friction; further, the belt would be much stretched, requiring constant adjustment of the dynamo to tighten it to avoid slip. And further, the occasional stretching of the belt produced by atmospheric changes would make the belt slip were the tension when the belt shortens again not far greater than is necessary for driving purposes. Hence the average tension of such a belt must be made to far exceed what a simple calculation of the necessary driving tensions would give, and the waste of power is in consequence also much in excess. Indeed, this is the reason why belting is usually placed more or less horizontal, and why long belts are employed with the upper side the slack side, so as to introduce a weight compensation, as seen in fig. 1.

Similar difficulties occur when an electro-motor, or other fast-speed motor, is used to drive machinery by means of belting.

Very many plans have been tried of overcoming this difficulty. For example, to increase the angle of contact of the short belt with the small driven pulley, and to keep the belt tight, Messrs. Mather and Platt used a large tightening pulley with their compact engine and dynamo at the Inventions Exhibition, an arrangement which they are at the present time employing at the Manchester Exhibition.

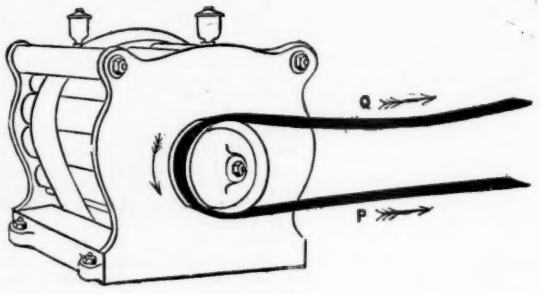



FIG. 1.

In transmitting power from an ordinary steam engine to a dynamo, or from an electro-motor to a tool, we have to gear a slowly and a fast rotating shaft, and the problem of doing this in a limited space and with small loss of power in overcoming friction has led to the many forms of "*friction gearing*" that have from time to time been devised. Indeed, one part of the joint work in telpherage carried out by the late Professor Fleeming Jenkin and ourselves was the designing of many modifications of such friction gearing, or, as it has been called, "*nest gearing*," for enabling power to be transmitted between a slowly and fast rotating shaft by means of a *pure couple without side thrust*. To enter into even a short description of these many forms would take up too much of your time; but we may mention that those interested in the subject will find descriptions of some of them in papers read before the Society of Arts and the British Association. The great objection to the employment of such friction gearing is the expense of construction, since adjustments have to be introduced to take up the wear of the rolling pulleys, which is considerable; hence, in spite of the ingenuity of friction gearing from a mechanical point of view, and of the captivation it has for those who are concerned with this problem of transmitting power between slowly and fast rotating shafts, it has not come into general use.

You are probably familiar with the form of friction gearing employed by Messrs. Siemens* for driving dynamos. The dynamo is balanced so as to turn on an axis at right angles to the axis of rotation of the armature and the dynamo pulley; the pulley is made of compressed paper, and rests on the top of the flywheel of the engine. The arrangement is good, since the force pressing the pulley against the rim of the flywheel is not all transmitted through the bearings, but is mainly furnished by the weight of the dynamo pulley. But this form of friction gearing has the following objections. First, the paper pulley has to be constructed in a very special way, under hydraulic pressure, and is necessarily much more expensive than an ordinary cast iron pulley. Secondly, the flywheel of an ordinary engine cannot be employed without having first its rim turned up true. Thirdly, the axes of rotation of the armature and flywheel must be placed accurately parallel to one another, otherwise there is a grinding action at the surface of the paper wheel, which destroys its surface. Next, it is a mistake to place the dynamo so that the paper pulley rests on the very top of the fly-wheel, since with this arrangement there is necessarily a side thrust on the bearings, and the power wasted in friction at the bearings cannot be made as small as is possible. And lastly, we are told by users of this form of gearing, that there is a tendency for the whole framework supporting the dynamo to get into a state of vibration. The result is that this method is not one by means of which any dynamo can be arranged so as to be driven directly by the fly-wheel of any engine, and is only employed when the engine and dynamo are constructed so as to form practically one piece of machinery.

A form of gearing employed for driving a dynamo with a gas-engine may be seen in the city, and at first sight this might appear to be merely the inversion of the gearing just described, because in this latter the pulley of the dynamo, instead of resting on the top of the engine fly-wheel, is pressed up against it below. But although this makes a less cumbersome arrangement, there is not any saving in the power wasted in friction at the bearings of the armature spindle, as there is in the Siemens gearing, since with the latter arrangement a force equal to the sum of the weight of the pulley and the force pressing the pulley up against the fly-wheel has to be transmitted through the bearings. It is not, therefore, necessary to consider this form of gearing in detail,

* Since the writing of this paper we have learnt that the ingenious method of driving is due to Mr. Raworth.

since it is not one that saves any portion of the waste of power in the friction at the bearings.

We now come to the new method which we wish to bring before you, and which consists in hanging the dynamo pulley, L, from a short belt passing round the engine fly-wheel, F, as seen in fig. 2, the belt being only just long enough to embrace the fly-wheel and dynamo pulley without the two being brought into contact. The dynamo, D, as in the previous case, is supported so as to turn round an axis at right angles to the axis of rotation of the armature, and the method of fixing the dynamo is as follows:—The pulley is removed from the spindle, S, and the dynamo is fixed in a cradle, C C, turning on trunnions, T, T, in such a position that the dynamo and cradle just balance. Then if $p_1$, $p_2$, be the pressures of the armature spindle on the two bearings, $B_1$, $B_1$, respectively nearer to and further from the pulley end of the dynamo, $p_1 + p_2$ = weight of armature, commutator and spindle.

The pulley, which is heavier than an ordinary dynamo pulley, but, like an ordinary pulley, simply made of cast-iron, is now keyed on to the armature spindle and hung in the belt, as seen in the figure, and as the entire weight of the pulley is supported by the belt, the dynamo by itself still balances, and the pressures on the bearings are simply $p_1$ and $p_2$, as before. The pulley is made of such a weight, and the cradle carrying the dynamo is placed in such a position relatively to the fly-wheel, that the resultant, R, of the tensions, P, Q, in the two sides of the belt, A B, B C, when the dynamo is receiving the maximum driving power, is equal to the weight of the pulley, and acts vertically through its centre, together with the necessary driving couple, V, V, as seen in fig. 3. The horizontal components of the tensions in the two sides of the belt are in equilibrium by themselves, so that the pressures exerted by the spindle of the armature on its bearings are simply equal to the weight of the armature, commutator, and spindle—that is, are even less when the dynamo is receiving the maximum driving power than in the case of an ordinary dynamo when the armature is *at rest*, since our form of belt gearing, unlike any ordinary belt, communicates *simply a pure couple* to the armature, instead of a couple together with a smaller or greater thrust of the spindle against the bearings.

And not only with this mode of driving need no extra pressure be thrown on to the bearings, but the pressure that is produced merely by the weight of the armature can be diminished. In fact the pressure on the bearing, $B_1$, nearer to the driving pulley *can be made actually equal to nought*, by slightly altering the adjustments in the following way:—Instead of fixing the dynamo in the cradle so that it balances when the driving pulley is removed, fix the dynamo a little nearer to the fly-wheel, so that the pulley end of the dynamo is a little the heavier, and move the cradle a corresponding distance away from the fly-wheel, so that the pulley, when keyed on to the armature spindle, and the fly-wheel are properly in line, Then the tensions in the two sides of the belt are balanced, not merely by the weight of the pulley, but by this weight plus any portion, or the whole, of $p_1$ depending on the exact position in which the dynamo has been fixed on the cradle. Hence the weight of the pulley may be made smaller by an amount equal to the portion of the pressure, $p_1$, which is carried by the belt, and the pressure on the bearing $B_1$, nearer the pulley which, with an ordinary dynamo, is by far the larger, can, with this arrangement, be made as small as we like, or even nought, whether the armature be at rest, or the dynamo be producing its maximum power. The pressure on the other bearing, $B_2$, will of course never exceed $p_2$, which is usually equal to about half the weight of the armature, commutator, and spindle. And, since the diameter of the spindle on the side farther away from the pulley can be made comparatively small, as power is not transmitted through it, the power spent in overcoming friction at this bearing, $B_2$, will be trifling. Hence the total waste of power at the bearings can be made practically nought by employing this form of belt-gearing.

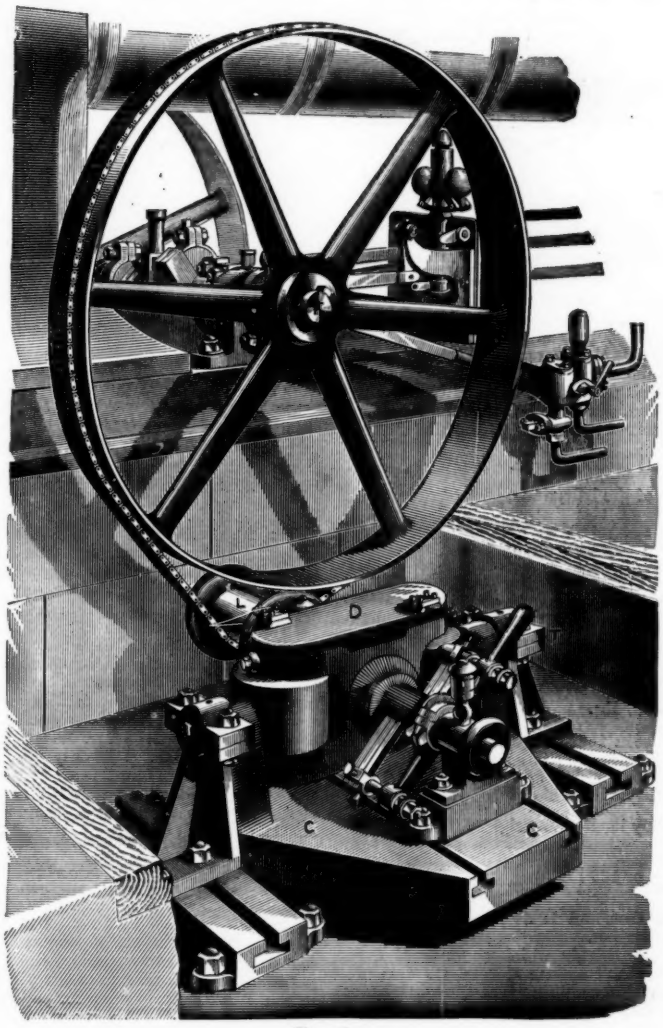



FIG. 2.

Floor in front seen removed to show clearly cradle supporting dynamo.

And, further, this gearing has the following advantages not possessed by the Siemens gearing:—

1. There is no paper pulley to be constructed and to wear out.
2. The rim of the engine fly-wheel need not be specially turned up.
3. The axes of rotation of the armature and fly-wheel need not be accurately parallel, as the yielding of the belt allows for want of perfect parallelism.
4. The cradle of the dynamo is low down, and therefore can be made steady.

It is also clear that any slight stretching of the belt will not cause it to become slack, since the only effect will be to lower the pulley slightly, and incline the axis of the armature to the horizontal.

To further illustrate this method of belt gearing, we give the actual calculations made for determining the proper weight to give to the dynamo pulley, and the proper position in which to place the dynamo, which is now being driven by a short belt at the Central Institution.

The four things to be determined are :—

1. Proper size of dynamo pulley.
2. Proper weight of „ „
3. Proper distance to place axis of armature below axis of flywheel.
4. Proper distance to place axis of armature to one side of axis of flywheel.

1. The dynamo in question requires about 6 horse-power when running at 1,600 revolutions per minute, and when giving out the safe maximum number of watts. The flywheel of the engine is 4 feet 11 inches in diameter, and runs at 180 revolutions per minute ; therefore, in order that the dynamo may be driven by a belt directly from the flywheel, the diameter of the dynamo pulley must be

$$\frac{180}{1600} \times 4' 11'', \text{ or } 6\tfrac{3}{4} \text{ inches.}$$

2. Let P and Q be the tensions, in pounds, of the belt on the tight and slack sides respectively, when the dynamo is receiving 6 horse-power, then

$$(P - Q) \times 1600 \times \pi \times \frac{53}{8 \times 12} = 6 \times 33000,$$

$$\text{or } P - Q = 71{\cdot}3, \text{ say } 72, \text{ lbs.}$$

If the rim of the dynamo pulley were in actual contact with the rim of the flywheel, it is easy to show that the angle between the belt on the two sides of the pulley would be 105°. The pulley and flywheel must not touch, since they would be moving in opposite directions at the place of contact, but, in order to make the arrangement compact, it is desirable that the pulley should be as near the flywheel as it conveniently can be without touching, therefore let us take 100° as the angle that the belt shall make on the two sides of the pulley. Then, since the belt makes a tangent with the pulley, the arc of contact of the belt with the rim of the pulley must be 180° − 100°, that is 80°, or $\frac{4}{9}\pi$. Therefore, if P be the tension of the tight side of the belt, and Q that of the slack side.

$$\frac{P}{Q} = \epsilon^{0{\cdot}4 \times \frac{4}{9}\pi}$$

$$\therefore \quad P = (P - Q)\frac{\epsilon^{0{\cdot}1778\pi}}{\epsilon^{0{\cdot}1778\pi} - 1}$$

and, as just shown, P − Q equals 72 lbs.

Therefore P = 169 lbs.,

and Q = 97 lbs.

By the triangle of forces it is seen that the resultant of P and Q equals 180 lbs. Therefore if the dynamo is so placed that half the weight of the armature and spindle, which is $\frac{94}{2}$ lbs., is borne by the belt as well as the pulley itself, the weight of the pulley must equal

$$180 - \frac{94}{2}, \text{ or } 133 \text{ lbs.,}$$

and a pulley of this weight was cast, and is at present in use on the dynamo at the Central Institution.

3 and 4.—To determine the position in which the axis of the armature should be placed below and to one side of the axis of rotation of the flywheel, we have the condition that the horizontal components of the tensions on the two sides of the belt should be equal and opposite in order that there may be no side thrust. Hence, if $\alpha$ and $\beta$ be the angles that the two sides of the belt make with the horizontal, fig. 3,

$$P \cos. \alpha = Q \cos. \beta,$$

$$\text{or } \frac{\cos. \alpha}{\cos. \beta} = \frac{Q}{P}$$

$$= 0{\cdot}574.$$

And since the angle between the two sides of the belt is 100°,

$$\therefore \quad \alpha + \beta + 100° = 180°,$$

$$\text{or } \beta = 80° - \alpha,$$

$$\therefore \quad \cos. \alpha = 0{\cdot}574 \cos. (80° - \alpha),$$

and expanding, we have

$$\tan. \alpha = \frac{1 - 0{\cdot}574 \cos. 80°}{0{\cdot}574 \sin. 80°}$$

$$= 1{\cdot}59,$$

$$\therefore \quad \alpha = 57° 50',$$

$$\text{and } \beta = 22° 10'.$$

Plotting these results to scale, it is found that the distance of the centre of the dynamo pulley below the centre of the flywheel must be 2 feet 8¼ inches, and the distance sideways 10¼ inches, a result which is also confirmed by calculation. And this is the position in which the dynamo was placed some six months ago.

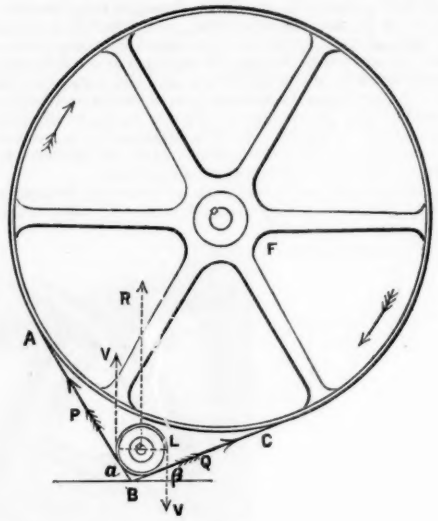



FIG. 3.

As a proof of our conservative familiarity with the ordinary method of driving a dynamo, instead of with the principles of belt gearing, the first remark made by almost every one who has seen the new gearing is, that the belt must slip very much. As a matter of fact, however, so far from there being any serious slip, experiment shows that the dynamo, when giving out its maximum power, rotates a little faster than the calculation makes it, due, of course, to the diameters of the flywheel and pulley not being exactly as stated in the calculation.

We need not dwell here on the fact that ropes may be used instead of belts. Again, when a number of dynamos have to be driven from one flywheel in a confined space, one driving belt may be used for all, and, by means of guide pulleys, arranged so that each dynamo pulley lies on the belt between two guide pulleys, the part of the belt on one side of each dynamo pulley being nearly horizontal and on the other side nearly vertical.

In the discussion which followed the reading of the paper, Mr. A. Siemens and Mr. G. Kapp took part.

Prof. W. E. AYRTON in reply said :—I must express my regret that in our paper we have not called the Siemens gearing by the name of its true inventor, Mr. Raworth, but having always heard it spoken of as the "Siemens gearing," we were not aware until to-night that it was to Mr. Raworth that the ingenuity of that arrangement is due. It is only too probable that my rough chalk sketch on the blackboard is as Mr. Raworth points out not complete in all its details, but I did not attempt when it was past 10 o'clock to make a working drawing, and my sketch must be understood as being merely suggestive of the Raworth gearing. I do not follow Mr. Siemens in seeing how it is possible to have no objectionable side thrust if the paper pulley be put on the top of the flywheel as I have always seen it done with the Siemens, or rather the Raworth gearing. It ought to be put slightly to one side of the flywheel and not on the top. The initial cost of a paper pulley may not be so very much greater than that of a cast iron pulley such as we employ, but the cost of maintenance which is rather what we refer to in our paper is, as far as my experience goes, certainly far greater for paper pulleys than for iron ones. Mr. Siemens says that you can order the flywheel of an engine to be turned true when it is being made. That is so, but if you have to deal with an ordinary engine in position, it is by no means such an easy matter to get the flywheel trued up. It would have to be taken off the engine and sent to the manufactory and even then, as it would not have been turned up on the engine shaft, it would probably be found to be out of truth when keyed on subsequently. The engine that is being employed to drive the dynamos at the Central Institution is not a special nor an antiquated form as Mr. Raworth seems to think, nor is it raised on 8 feet of brickwork. It is one of Marshall's semi-portable compound engines, and was bought secondhand at the sale of the stock of the Hammond Company, in whose factory it had been in regular use for driving dynamos. The engine is fitted with two flywheels one on each side, one being employed at the Central Institution to drive coned shafting. From this shafting several dynamos are driven, and the speed of any one of them can be varied between wide limits without affecting the speeds of the others. From the other flywheel hangs the balanced dynamo as shown in fig. 2, and the engine is not mounted on 8 feet of brickwork as suggested by Mr. Raworth, but the dynamo is placed in a shallow hole dug out of the floor to receive it with its cradle on which it rests. The hole is not really as large as would appear from the figure, but in the figure the floor in front is

seen cut away to show clearly the cradle supporting the dynamo. I think, then, that we are justified in saying that our form of gearing is applicable to any ordinary form of steam engine, whereas the Raworth gearing is only employed when the engine and dynamo are constructed so as to form practically one piece of machinery. My reason for considering that our gearing can be made more free from vibration than Mr. Raworth's is, that with ours the dynamo and cradle are low down, while with his they are mounted several feet up in the air. As to Mr. Raworth's criticism that if many dynamos were driven with one belt or rope, as suggested at the end of our paper, the dynamos would tip up, I merely reply that it is a simple question of calculation to adjust the angles of the belts and the weights of the pulleys so that the tensions on the various parts of the belt shall merely produce the necessary driving couples and a set of forces respectively equal and opposite to the weights of the various dynamo pulleys, or to the weights of these pulleys plus any portions of the weights of the armatures which, as explained in our paper, may be carried also by the belts. In fact, if the method of calculation described in our paper be followed, and the various parts of the belt be made to have the angles given by the calculation and also the pulleys the proper weights, there will be no tipping action such as Mr. Raworth fears. Next, in reply to Mr. Kapp:—I do not at all follow him when he says that Rankine gives 0·235 for the coefficient of friction, since we find in Rankine 0·56 for leather on dry metals, and 0·36 for leather on wet metals; further, Rankine says that for the general driving of metal pulleys by leather belts, it is quite safe to take 0·42 as the coefficient of friction. Now this is actually a higher number and not a lower one than the coefficient of friction that we have employed in our calculation. Mr. Kapp's calculation as to the necessary weight to give to the pulley I, therefore, do not assent to. But even if he were correct in his value of the coefficient of friction, and even if it were necessary to have such a heavy pulley as he makes out, there would not be the disadvantage that he imagines, since a heavy pulley and a heavy flywheel may be made in very different ways. A pulley may be made heavy by putting the mass near the axis, whereas a flywheel to have a considerable moment of inertia must have its mass far from its axis of rotation, and it is only then that inequality in the density of the metal becomes serious. Then bear in mind the weight of the heavy pulley is not borne by the bearings of the dynamo, the pulley simply rests in the belt. In fact, the heavier it be necessary to make the pulley for efficient driving the more valuable is our arrangement, since the weight of our pulley which is carried entirely by the belt, and which therefore exerts no pressure on the bearings of the dynamo is under ordinary circumstances replaced by the pressure exerted through the bearings. No greater pressure on the belt is required by our method of driving than by any other with the dynamo equally near the flywheel, the only difference is that in our case we produce the pressure on the belt *solely by gravity*, whereas usually it is *wholly transmitted through the bearings* of the dynamo producing a corresponding amount of waste of power in friction.

## Physical Society, June 25th.

Mr. SHELFORD BIDWELL, F.R.S., Vice-President, in the Chair.

The following communications were read:—"Note on Magnetic Resistance," by Prof. W. E. AYRTON F.R.S., and Prof. J. PERRY, F.R.S. In the spring of 1886 the authors made experiments on the magnetic induction through horse-shoe electro-magnets when excited by constant currents. The inductions through different armatures and air spaces were also measured. The results show that for small exciting powers the law of parallel resistance is true for magnetism, taking leakage into account. From experiments made with two electro-magnets, the poles of which were placed at different distances apart, the authors conclude that the magnetic resistance of air is proportional to length, or to length plus a constant.

A note on "Magnetic Resistance" was read before the society on the 12th of March, 1887, by the same authors, describing experiments on two iron rings, one whole and the other divided by a radial saw cut. Since then the experiments have been repeated with great care by Colonel Swinton and Mr. Sorënson, of the Central Institution. The resulting curves agree with those previously obtained. On measuring the air space it was found considerably less than estimated, and the magnetic resistance of air relative to iron (assuming no "surface resistance") comes about 1,500. Experiments made with different air spaces, together with the above, seem to show a considerable "surface resistance."

Prof. S. P. THOMPSON thought dynamo makers had evidence of such "surface resistance," from the care exercised in avoiding joints in the magnetic circuit wherever possible, and Mr. BOSANQUET mentioned some experiments he had recently made on the resistance of joints during the various stages of fitting. The changes of resistance are very large, and he concludes that however good the fit, it is not possible to reduce the surface of resistance to a negligible quantity.

"On Sounding Coils," by Prof. W. STROUD, D.Sc., and Mr. J. WERTHEIMER, B.Sc. The paper describes experiments on coils and helices of wire which emit sounds when variable electric currents are passed through them. The pitch depends on the frequency of the current variations. The authors believe the sounds due to the attractions of adjacent parts of the wire which cause shortenings and lengthenings as the current increases or decreases. To prove this two identical coils were made, and one of them embedded in plaster of Paris. This gave no sound when the variable current was passed, whilst the other emitted the usual note. It was also found that no sound could be got from a single turn of wire, whilst one and a-quarter turns gave an audible sound under the same conditions.

"On Comparing Capacities," by Mr. E. C. RIMINGTON. This is an investigation of the conditions under which the integral current through a galvanometer in a balanced Wheatstone's bridge is zero when the battery circuit is broken, two adjacent arms, A and D, of the bridge being shunted by condensers of capacities $K_1$ and $K_2$. It is shown that $\frac{K_1}{K_2} = \frac{C}{B}$, where C and B are the resistances of the arms opposite to A and D respectively. If A and D be made infinite the necessity of balancing for steady currents is obviated, but if either of the condensers has an appreciable leakage, corrections are required. The best resistance to give to the galvanometer is shown to be $G = \frac{B(C + D)}{B + C}$, and the conditions under which a telephone may replace the galvanometer are $\frac{K_1}{K_2} = \frac{C}{B}$. The case where all the arms have self-inductions is investigated.

"On permanent magnet ammeters and voltmeters of invariable sensibility," by Prof. W. E. AYRTON, F.R.S., and Prof. J. PERRY, F.R.S. The sensibility of ordinary permanent magnet ammeters and voltmeters increases as the strength of the magnet decreases, whereas in those of the Deprez-D'Arsonval type (in which a suspended coil controlled by torsion swings between the poles of a permanent magnet) the reverse effect takes place. By combining the two systems the authors have devised instruments whose sensibility is unaltered by changes in the strength of the magnet. The torsional control of the D'Arsonval is removed and a small permanent magnet attached to the swinging coil. As the large permanent magnet changes, the controlling and deflecting forces change in the same proportion, and the deflection for a given current remains unaltered.

# CORRESPONDENCE.

### Practical Electrical Measurement.

In the very interesting article on "Practical Electrical Measurement," by Mr. Swinburne, in your issue of July 1st, occurs the following paragraph: "Profs. Ayrton and Perry read an elaborate paper before the Physical Society (June 13th, 1885), in which, starting with certain assumptions, they showed that to make the power error least, voltmeters should be wound with German silver. The writer dissents entirely from this view, as the assumptions are unwarrantable." Permit us to state that no such conclusion as this was arrived at by us in the paper in question, nor has it been stated by us anywhere else. For we examined the question whether German silver wire should be used either for the inner convolutions, or for the outer, of a voltmeter of the dimensions of our magnifying spring voltmeter, and we arrived at the result that to make the power error a minimum, copper was better than German silver for *all* the convolutions. Further, in no one of the thousand or more of our voltmeters (permanent magnet, magnifying spring, &c.) that have been constructed has the coil ever been wound with German silver wire. It is, therefore, an oversight to attribute to us the advocacy of winding voltmeter coils with German silver wire.

Mr. Swinburne goes on to say that "Some makers prefer to wind voltmeter coils with copper wire and to put an external resistance of German silver wire in series, and where this can be done it is the best arrangement." But that is exactly the arrangement that was shown by us to be best in our paper read before the Physical Society in 1885, and is the one that the makers of our measuring instruments regularly employ for high-range voltmeters. Even the determination of the best resistance to give to this outside coil of German silver wire was entered into in the paper just referred to, as well as the determination of the best volume and the best resistance to give to the outside coil for a given permissible power error.

The article in your last issue ends by stating "In such instruments as Schuckert's, Statter's, and Ayrton and Perry's, the best effect would be got by winding

the inside layers of fine wire, especially the parts where the ampère turn has most action, and a turn of wire is short. A voltmeter might generally be wound with two sizes of wire with advantage." It is to be observed that the words are not "the best effect *is* got," but "the best effect *would be* got," &c. Mr. Swinburne has, therefore, forgotten that the main object of our 1885 paper, "On the Winding of Voltmeters," was to determine "what should be the law of variation of sectional area of the wire, with the diameter of the convolution on which it is wound." The result obtained for an instrument of the dimensions of our magnifying spring voltmeter was that of $x$, the diameter of the wire at any distance, $r$, from the centre of the instrument, and $x_0$ be the radius of the bobbin on which the first convolution of wire is wound;

$$x = x_0\, r^{0.42}$$

gives the power error a minimum. Now this law not only contains the general conclusion he arrives at, viz., that finer wire should be used inside than outside, but in addition it shows exactly how the thickness of the wire should increase with the diameter of the convolution. Mr. Swinburne is also probably unaware of the fact that the exact value of each of the different convolutions of wire on our magnifying spring instruments was very carefully determined experimentally, and that not merely are two sizes of wire used in winding one of our voltmeters but three.

When on the subject of "motor-meters" Mr. Swinburne explains quite properly the defects of the Siemens meter, which is a *coulombmeter*, and he concludes that portion of his article by stating, "The difficulty arising from the resistance in the main circuit in motor-meters may be overcome by using an electromagnet instead of a permanent field magnet, and having the core very soft and slightly magnetised. The field magnet is excited by the main current, and may easily be made without appreciable resistance. The armature is then put in a high resistance circuit in shunt to the installation; any slight resistance at the brushes is then insignificant." Mr. Swinburne does not draw attention to the fact that this improvement, which he suggests as being necessary to be employed to make the Siemens coulombmeter a trustworthy meter, transforms it from a coulombmeter into an erg or joulemeter, nor does he mention that his description of this improved instrument is simply that of our ergmeter as given in our patent specification of 1882. Some two or three years ago Messrs. Siemens, possibly seeing the defect of their permanent magnet coulombmeter, gave an account of the very improvement Mr. Swinburne now suggests, but we have heard nothing further of that improved instrument since we pointed out in your columns at the time that it was simply our ergmeter of 1882. We refer, of course, to our motor ergmeter, not to our clock ergmeter patented at the same time.

And in view of the considerable attention that has during the last few weeks been drawn to clock electricity meters in the ELECTRICAL REVIEW and other technical journals, we may say a word about the so-called Aron meter, on which we have been hitherto silent. When we described our clock ergmeter in 1882, we pointed out that if a perfectly constant potential difference were maintained at the terminals of any installation our ergmeter became simply a coulombmeter, because our high resistance fine wire pendulum bob with the constant potential difference at its terminals then acted simply as a permanent magnet. Some time after that, Dr. Aron availed himself of this idea and constructed a coulombmeter with a permanent magnet pendulum. As, however, the high resistance fine wire pendulum bob is far better than a permanent magnet pendulum in all cases, we let the matter pass. The reason why the high resistance fine wire pendulum bob is better than the permanent magnet pendulum is as follows:—if the potential difference maintained at the terminals of the house be absolutely constant, then the joules and coulombs supplied in any time are exactly proportional one to the other, and as the high resistance fine wire pendulum acts as an infinitely hard magnet, or magnet of absolutely constant strength, the ergmeter acts like a coulombmeter of greater accuracy than can be obtained with a permanent magnet pendulum. If, on the other hand, the potential difference fluctuates, then our ergmeter takes notice of this, and the householder is not compelled to pay for a higher potential difference than he is supplied with as he would be if furnished with a permanent magnet pendulum meter.

The next improvement we suggested was the use of two pendulums, one to beat true seconds, the other to suffer a retardation depending on the amount of electric energy supplied to the installation. To make this fact quite explicit, we may mention that one of us was in favour of the general adoption of this double pendulum in all our ergmeters, while the other of us was of opinion that, in consequence of the complexity it introduced into the apparatus, it was desirable to confine this improvement to special ergmeters. As, however, this improvement of ours was probably not known in Germany, we still held our peace when Dr. Aron employed this principle, but when, as seen from fig. 4 of the article on "Dr. Aron's Electricity Meters" in *Industries* of June 24th, we find that Dr. Aron is now even employing a high resistance fine wire pendulum bob as a shunt to the whole installation in addition to the stationary thick wire coil through which the whole current passes, we must ask Mr. Swinburne to allow us to still use the word "ergmeter" (in spite of our agreeing with him that the word "joulemeter" is probably better), because the name is the only part of our meter that has not yet been appropriated by Dr. Aron.

That the so-called Aron electric meter should have on it the words "Agents Binswanger & Co." is interesting, seeing that the large illustration of a proposed electric tramway to be constructed on our *sectional system*, patented in 1881, and actuated by one form of our *automatic magnetic contact makers*, which appeared in the ELECTRICAL REVIEW some time back, and which it was our intention to leave unnoticed until the proposed tramway was constructed, had attached to it the words, "Pollak's and Binswanger's System."

**W. E. Ayrton.**
**John Perry.**

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### Telegraphic Communication with the Colonies.

I have been much interested by the extract from Australian Handbook for 1887 *re* Telegraphic Communication between England and Australia, which you give in your issue of 24th June. Will you kindly tell me where the handbook can be obtained, and the price of it?

**R. Somerset.**

*June 30th*, 1887.

[The Australian Handbook is published by Messrs. Gordon & Gotch, of St. Bride's Street, Ludgate Circus. —EDS. ELEC. REV.]

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### The Explosion of Glow Lamps.

I have just seen the letter by Mr. W. H. Preece in the ELECTRICAL REVIEW of June 17th last on the above subject, and it has brought to my mind the case of an explosion of a glow lamp which took place in my hands some three years ago. It is, as nearly as I can remember, as follows:—

I was fitting up some 16 C.P. Edison lamps on a 110 volt circuit when, by some accident, I put up one of 55 volts. Directly connection was made the lamp exploded with the noise of a gun, and on examining it I could not find any crack in the glass, but the carbon was broken up into short lengths. I cannot see what caused the explosion or how it was produced without the glass being broken.

**B. F. Howard.**

*July 6th*, 1887.